1985

Determinants of the Money Supply in the United Kingdom, West Germany, and Canada (Central Bank, Reaction Function, Inflation, Fiscal, Monetary Policy).

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The Louisiana State University and Agricultural and Mechanical Col. PH.D. 1985

University
Microfilms
International 300 N. Zeeb Road, Ann Arbor, MI 48106

DETERMINANTS OF THE MONEY SUPPLY IN THE UNITED KINGDOM, WEST GERMANY, AND CANADA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Economics

by

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December, 1985

To my family

ACKNOWLEDGMENT

The author has great pleasure in expressing her sincere gratitude to Professor Thomas R. Beard for his valuable guidance and interest throughout this research. Special thanks to Dr. W. Douglas McMillin for his constructive criticism and advice in the course of work. I also take this opportunity to thank the other members of my Dissertation Committee, Professors James A. Richardson, G. Randolph Rice, Jeffrey L. Ringuest, and Robert E. Martin for their help and useful suggestions. My thanks are extended to my husband, Dr. Vinod K. Gupta, for his continuous cooperation and encouragement. My appreciation is also extended to Patricia Knight and Marsha Panichas for their friendship. Finally, I would like to thank Louisiana State University for the financial support, and to Wanda Holmes-Frazier for excellent typing assistance.

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ABSTRACT

The primary purpose of this study is to formulate, estimate and compare monetary policy reaction functions for the United Kingdom, West Germany, and Canada. For each country, the growth rate of the monetary base is estimated as a linear function of eight independent variables--the interest rate variable, the budget deficit variable, the wage rate variable, the price variable, the international reserves variable, the exchange rate variable, a trade balance variable and an economic activity variable (e.g., the output gap, the output ratio, or the unemployment rate variable). Alternative measures of a number of these variables are employed.

The Final Prediction Error criterion in conjunction with the specific gravity criterion has been used to determine the lag length for each explanatory variable and the order in which independent variables enter the equations. Reaction functions, thus specified, are estimated using the Ordinary Least Squares and instrumental variables techniques. If preliminary results suggest the presence of serial correlation among residuals, estimates are obtained using the Cochrane-Orcutt iterative procedure for serial correlation correction. Restricted versions of the reaction functions are also estimated after dropping statistically insignificant variables from the fully specified reaction functions.

The estimated reaction functions indicate that monetary policies in the United Kingdom and West Germany have been permanently affected by some external trade balance measure--the effective exchange rate in the former case and international reserves in the latter. The monetary base in Canada is affected by changes in the output gap, interest rate changes and budget deficits.

CHAPTER I

NATURE AND SCOPE OF STUDY

Inflation is one of the most prominent problems faced by developed as well as less developed countries. It has been generally agreed upon that "inflation is always and everywhere a monetary phenomenon"; thus, to understand the inflationary process it is essential to analyze the factors that contribute to rapid money growth. The purpose of this study is to explore the factors responsible for monetary expansion in the United Kingdom, West Germany, and Canada.

Prior to the early 1960's, almost all macroeconomic models specified variables determined within the governmental sector as exogenous. Changes in these variables constituted shocks to the system and empirical studies employing the assumptions that government variables were exogeneous estimated multipliers for these variables.

More recently, however, there has been a growing volume of research in which the primary purpose has been to endogenize policy variables. This research has originated from different sources. It has been carried on by a number of economists [e.g. Dewald-Johnson (1963), Reuber (1964), Havrilesky (1967)] concerned with analyzing the performance of policymakers. These economists have typically estimated reaction functions for the monetary authorities. In some cases they have attempted to judge whether the monetary authorities actually implemented their announced policy objectives; in other cases, reaction functions have been estimated to ascertain the implicit trade-off among various policy targets.

Econometric model-builders interested in improving their estimates of structural and reduced form parameters have also contributed significantly to this field. As Wood (1967) pointed out, to treat the monetary policy variable as exogeneous, while in fact it is influenced by economic and other variables, constitutes a specification error. Misspecification of the model results in inconsistent and biased parameter estimates. Wood (p. 137) asserted "If monetary policy actions do in fact affect the behavior of private institutions and individuals, it is necessary to treat the Federal Reserve behavioral equations as part of a larger model in order to obtain consistent estimates of the parameters of those equations".

If government policy variables are endogeneous, assuming them to be exogeneous may lead to simultaneous equation bias in the estimation of a structural econometric model. According to Goldfeld and Blinder (1972, p. 593) "...the only 'right' way to estimate policy multipliers econometrically is to include in his [economist's] model reaction functions for the fiscal authorities and for the Federal Reserve System...". They argue that the multiplier would be biased if policymakers react systematically to the state of the economy and this systematic reaction is not accounted for in the model.

The primary purpose of this study is to contribute to this research by formulating, estimating and comparing monetary policy reaction functions for the United Kingdom, West Germany, and Canada. Reaction functions quantify the manner in which the monetary authorities alter the money supply in response to various goals such as price stability, full employment, balance of payments equilibrium, and economic growth. Extensive empirical evidence is available on the estimation of the U.S. money supply reaction function (as is evident from the number of studies covered in Chapter II), but comparatively fewer studies are available for the countries covered in this study. In most previous studies, a-priori restrictions are imposed on the model in terms of the predetermined lag length. An attempt has been made in the present study to avoid the problems associated with the imposition of the same lag length on all explanatory variables. A better understanding of the actual behavior of monetary authorities in the U.K., West Germany, and Canada would help make fiscal policy makers in these countries better equipped to handle such macro problems as inflation and unemployment. Empirical estimation of reaction functions will facilitate the understanding of the monetary policy mechanism in these countries.

In this study we focus on the growth rate of the monetary base rather than on the money supply. The growth rate of the monetary base is estimated as a linear function of changes in economic variables. Reaction functions are estimated using ordinary least square procedures. Data are analyzed using a Time Series Processor (TSP) package. Rather than imposing an artificial lag structure, information contained in the data set is used to determine the lag length for each variable. The Final Prediction Error (FPE) test of Hsiao (1981) is used in conjunction with the Specific Gravity (SG) criterion of Caines, Keng and Sethi (1981) to determine the lag length on each variable and the order in which explanatory variables enter the money growth function.

It should be mentioned that this study does not attempt to investigate several related issues. No consideration is given to explaining the determination of central bank instruments such as open market transactions or operating targets such as short-term interest rates or some aggregate of bank reserves. Rather, the focus is completely on the nominal quantity of the monetary base, and it is assumed that its value is approximately determined by the monetary authority in each country.

A brief outline of the study follows. Chapter II contains a summary of previous empirical research on money supply reaction functions for the United States and other industrial countries. In Chapter III the theoretical framework underlying the empirical analysis of this study is outlined, followed by the detailed specification of the monetary base equations and the expected sign on the variables. Chapter IV contains the results for the United Kingdom, West Germany, and Canada. The final chapter (Chapter V) summarizes the study and the results.

Appendix A consists of definitions of variables used in the estimation of the reaction functions.

CHAPTER II

A SURVEY OF THE LITERATURE

Before elaborating on the model used in this study, it is useful to survey the existing empirical literature on the reaction function estimation.

I. Different Approaches To Explanatory Variables

A number of view-points about monetary expansion can be distinguished. Many monetarists suggest that large government deficits may be a major source of monetary expansion. Large scale fiscal deficits occurring year after year can not be financed by the sale of government bonds to private individuals and non-banking institutions without destabilizing financial markets. Under such conditions, the alternative option available to the government is to finance deficits by money creation.

As pointed out by several monetarists, the sale of government securities to the private sector will exert upward pressure on interest rates. To the extent that the central bank is concerned with avoiding large fluctuations in interest rates, it will buy at least a part of the outstanding government securities, thus monetizing a part of the government debt. However, the central bank will not use accommodative monetary policy if its concern with macro-stabilization objectives (such as a low inflation rate or balance of payments objective) is greater than its concern for the interest rate objective (McMillin - Beard, 1980).

Another channel which is operative even in the presence of unchanged Federal Reserve behavior is discussed by McMillin and Beard (1980). The increased sale of government securities issued to finance a budget deficit will lead to increased short-term interest rates. Higher interest rates can cause an expansion in the money supply through changes in private sector responses such as a reduction in the ratios of excess reserves/demand deposits and time deposits/demand deposits. This expansion in the money supply will take place even if the monetary authorities' behavior remains unchanged in response to changes in market interest rates.

Many Keynesians insist that cost push factors such as wage or oil price increases provide a major explanation for the behavior of the money stock. Increases in money wages in excess of increases in labor productivity would lead to higher unit labor costs and price level. If money wages and prices are inflexible downward and the monetary authorities do not expand the money stock in response to increased nominal wages, the level of employment and output would decline. Because of the squeeze in real balances, financial markets would be unstable, i.e., interest rates will tend to move upward. To the extent that the authorities are concerned with financial stability and the employment objective, they will be constrained to accommodate wage increases.[1]

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[1]Gordon (1977) has noted the effect of wage increases on money supply "...Sooner or later the central bank will have to raise the money supply in order to accommodate the higher transaction demand for money created by higher wages..." (p. 415).

Another factor that can affect the money supply process in an open economy is the balance of payments. Since the monetary base is comprised of the sum of domestic credit and net foreign assets of the central bank, changes in net foreign credit arising due to the changes in the balance of payments situation may lead to changes in the monetary base and the money supply. Thus, a balance of payments surplus can cause monetary expansion.

The purpose here is to present a comprehensive review of the available literature on money supply determinants. The emphasis is on studies in which an attempt has been made to estimate the central bank's reaction function. If the monetary authorities react systematically to the state of the economy, estimation of this systematic reaction pattern is warranted in order to detect the determinants of monetary policy.

II. Estimation Results: Money Supply Reaction Functions

A. U. S. Studies

A summary of some previous reaction function studies for the U.S. is reported in Table 1. These studies are presented in chronological order. Most reaction function studies start on the assumption that the central bank tries to maximize some policy objective function (or minimize the loss function)[2] with appropriate weights assigned to price stability, full employment, interest rate stability and the

[2]Most often the loss function (objective function) is quadratic with linear constraints and an additive error term. The optimization process results in a linear reaction function which is amenable to statistical analysis.

Table 1. Summary List of Major Money Supply Reaction-Function Studies for United States.

Study	Sample Period[a]	Regressand	Form	Lagged Regressand	U	P	BPS	Y/P	Y (TS)	XR	r	FEDV	SUR	FED	DEF	W	M	DEBT	Y* (GAP)	FES (DEF)	G	T	ED
1 Dewald-Johnson (1963)	1952:1-1961:4;Q	Money Supply (M1, M2, log M1)	Level	+	+	0	0	+															
2 Havrilesky (1967)	1952:1-1965:4;Q	Total reserves	Level		+	-	0[c]		+														
3 Wood (1967)	1952:1-1963:4;Q	Gov't. securities held by the Federal Reserve	Change (First difference)		0	-	+		-									+					
4 Froyen (1974)	1953:2-1961:1;M 1961:2-1969:1;M 1969:2-1972:2;M	Monetary Base (MB)	Level		+ + +	0 - 0	0 0 +		(+) (+) (+)		0 0 0							0 + 0		0 - 0			
5 Havrilesky, Sapp and Schweitzer (1975)	Easy money[d] periods; M Tight money periods;M	Federal Funds Rate	Percent Change (growth rate)		- 0	±[e] +			0[e] ±[f]														
6 Barro (1978)	1941-1976;A 1946-1976;A	Money Supply (M1)	Annual Growth Rate	+	+							+	0										
7 Moore (1979)	1951:2-1977:2;M 1952:2-1976:2;Q	Monetary Base (MB)	Level, First Difference, Percentage Change		-	+				+	0[h] -					+							
8 McMillin-Beard (1980)	1953:1-1976:4;Q	Unborrowed Reserves	Level			+			+		-								+	+	+	-[l]	
9 Abrams, Froyen and Waud (1980)	1970:3-1977:3;M	Federal Funds Rate	Level	+	-	+[i]				+							+						
10 Hamburger-Zwick (1981)	1954:1976;A 1961:1974;A	Money Supply (M1)	Annual Growth Rate	+	+									+ 0	0[g] +								
11 Levy (1981)	1952:1-1978:4;Q	Monetary Base (MB)	First Difference	+	0	+					0							+	0				
12 Barth, Sickles and Weist (1982)	1953:1-1978:2;M	Monetary Base (MB)	Monthly Percentage Change		+	-			(+)		0									-			
13 McMillin-Beard (1982)	1961 - 1974;A 1961 - 1978;A	Money Supply (M1)	Annual Growth Rate	+										0[k] +	0 0			0[j] 0					
14 Allen and Smith (1983)	1954:1-1980:4;Q[b]	Monetary Base (MB)	Quarterly Growth Rates	+										0				+					
15 Laney-Willett (1983)	1960 - 1976;A	Money Supply (M1)	Change	+		-		+								+			(-)	(+)			0

See notes and definitions of variables on pp. 9-12.

Notes:

M1 refers to the narrow money supply defined as C+D

M2 refers to a broader definition of the money supply measured as C+D+T,

where:

C = Currency,

D = Demand deposits, and

T = Time deposits in Commercial banks.

+, - and 0 denote respectively a positive significant sign, a negative significant sign and insignificant sign on coefficients at the 5% level.

[a]Q denotes quarterly, A denotes annual and M denotes a monthly time unit.

[b]This estimation period has been broken into several subperiods to test for structural shifts in the money supply function between the subperiods. Separate equations have been estimated for (i) 1954:1-1961:2, (ii) 1961:3-1974:4, (iii) 1954:1-1974:4; (iv) 1961:3-1969:3, (v) 1969:4-1980:4, (vi) 1961:3-1980:4 and (vii) 1954:1-1980:4.

[c]Although the balance of payments variable was not significant, a significant negative coefficient on a proxy variable for foreign economic activity (a weighted average of foreign long-term interest rates) indicated responsiveness of monetary policy to capital flows.

[d]A ten year time period (1964:1 - 1974:2, M) was divided into several subperiods on the basis of intended "tight" or "easy"

monetary policy as stated in the minutes of FOMC monthly meetings. Reaction functions for six distinct sub-periods were estimated.

[e]These coefficients were significant with different signs in different easy money periods.

[f]This coefficient changed in sign in different tight money periods.

[g]A change in the nature of the relationship between money supply and federal expenditure was observed. Over the extended sample (1954-76) government expenditures, rather than deficits, explained monetary growth, but for a smaller sample period (1961-74) the money supply reacted to changes in deficits rather than to expenditures.

[h]The short run interest rate variable has a negative sign but is insignificantly different from zero for the monthly data, however, for the quarterly data the interest rate coefficient is significant at the one percent level with a negative sign.

[i]This variable is significant for the simplest reaction function estimated.

[j]Significant at the ten percent level, with the expected positive sign in only one of the equations in which the expenditures and deficits variables were dropped.

[k]For a longer sample period (1961-78) a positive link was established between federal expenditures and money growth, but this link was significant only when a deficit or a debt variable was included in the estimated equation.

[l]In addition to these variables several dummy variables corresponding to different presidential administrations were included to test any shifts in Federal Reserve behavior.

Definition of Variables:

U = Unemployment rate;

P = Inflation rate or the absolute change in price index;

BPS = Balance of payments surplus;

Y/P = Real income;

Y = Nominal income;

XR = Exchange rate;

r = Short-term interest rate, (different specifications include treasury bill rate and the federal funds rate);

FEDV = Real federal expenditure relative to normal;

SUR = Detrended federal surplus [nominal surplus/(Trend real GNP x IPD)];

FED = Detrended government expenditure [nominal federal expenditure/(Trend real GNP x IPD)];

DEF = Detrended federal deficit [nominal deficit/(Trend real GNP X IPD)];

DEBT = government debt;

W = Wage rate;

M = Money supply (deviations of the money growth rate M1 from the targeted growth rate);

Y^* = Potential GNP (high employment output);

TS = Total sales;

FES = Full employment budget surplus

G = Nominal federal government expenditures on goods and services;

T = Nominal endogenous federal net tax receipts;

GAP = Output gap (difference between actual output and potential output);

DFE = Full employment budget deficit;

ED = Election dummy variable (This variable is assigned a value equal to plus one in the year of an election and one preceding year, and is equal to minus one for the two following years).

balance of payments equilibrium objectives. This optimization process is subject to a set of relationships representing the structure of the economy, which generates a trade-off between several objectives. The reaction function is derived by solving the first-order conditions.

In the reaction functions reported in Table 1, a total of seven dependent variables have been used.[3] The choice of the regressand was based on either the overall purpose of the author's study or his belief regarding the nature of the monetary aggregate which the authorities have actually controlled. Dewald and Johnson (1963, hereafter D-J) estimated the money supply reaction function primarily to learn about the goals trade-off. D-J tried both M1 and M2 (as a monetary policy indicator) in the estimated reaction function. They reported a slightly higher multiple correlation coefficient adjusted for degrees of freedom ($\bar{R}^2$) for M2, and also that it was weaker with respect to correct signs and significance levels. Barro (1978) and Hamburger and Zwick (1981) have used M1 to estimate the money growth equation and to test the deficit-money supply linkage. Abrams, Froyen and Waud (1980) preferred the federal funds rate as the dependent variable, since they felt that this policy instrument was under the direct control of policymakers over their sample period. Havrilesky (1967) rejected both the money supply and interest rates as indicators of monetary policy in favor of total reserves (adjusted for legal reserve requirement changes). He argued that neither the money supply nor interest rates were under the direct control of the monetary

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[3]Different specifications of dependent variables included M1, M2, total reserves, federal funds rate, the Fed's holding of government securities, the monetary base and unborrowed reserves.

authorities since they are influenced by exogenous forces. Wood (1967) used the government securities held by the Federal Reserve as the appropriate dependent variable in the estimated reaction function, while the monetary base was chosen as the monetary policy variable by Levy (1981), Barth, Sickles and Weist (1982), and Allen-Smith (1983). Unborrowed reserves (adjusted for reserve requirement changes) are employed as the Federal Reserve's 'policy tool' by McMillin-Beard (1980). A discussion of individual money supply reaction function studies (in chronological order) now follows.

D-J (1963) specified four major goals of the monetary authorities--price stability, high employment, economic growth and a satisfactory balance of payments. They also analyzed the trade-off among these policy objectives. Empirical evidence indicated that during the sample period (1952-1961) high employment and high economic growth objectives dominated monetary policy. This was because changes in the unemployment rate and real gross national product were found to be the major sources of the changes in monetary policy as represented by the money supply (M1 and M2). The coefficients on the balance of payments variable and price level variable were statistically insignificant and had wrong signs, leading them to the conclusion that the external balance objective and the price stability objective did not shape monetary policies in the sample period under consideration.

In a monetary policy reaction function estimated by Havrilesky (1967), total reserves (adjusted for legal reserve requirement changes) were regressed on unemployment, the general price level, the balance of payments and aggregate demand variables. Quarterly data were used for the sample period (1952:1 - 1965:4). Empirical evidence indicated that the monetary authorities responded systematically to changes in the unemployment rate, the price level and aggregate demand. All these variables were significant with the expected sign. Although the balance of payments variable was not significantly different from zero, a significant negative coefficient on a proxy variable for foreign economic activity (a weighted average of foreign long-term interest rates) indicated responsiveness of monetary policy to capital flows.

Wood (1967) investigated Federal Reserve behavior within the context of the entire economy. The reaction function was formally derived using an optimization procedure. The Federal Reserve was perceived as minimizing a disutility function containing the weighted squared sum of deviations of actual from desired values for some basic objective variables. This function is minimized subject to the constraints that are reduced form equations embodying the perceived structure of the economy.

The derived reaction function was estimated using ordinary least squares and two-stage least squares procedures for the time period 1952:1- 1963:4. Quarterly data were employed. Evidence revealed the systematic response of the Federal Reserve to changes in GNP, the balance of trade and the price level. Federal Reserve holdings of government securities also responded directly to a change in holdings of federal securities outside the Treasury.

Froyen (1974) estimated separate functions for the Eisenhower (February 1953 - January 1961), Kennedy-Johnson (February 1961-January 1969), and early Nixon (February 1969-February 1972) regimes. In the estimated reaction functions, the monetary base (and adjusted monetary base) was regressed on the unemployment rate variable, the inflation rate variable, the balance of payments surplus, total sales (a proxy for the level of economic activity) and the long-term corporate bond rate. In addition to these variables he included the federal government debt and the full employment budget surplus as fiscal policy variables. He found evidence that monetary policy was sensitive to the changes in the unemployment rate and the level of economic activity, irrespective of the political regime. Anti-inflationary monetary policy was pursued only during the Kennedy-Johnson administration. Over this period (February 1961-January 1969) monetary policy also responded to the changes in fiscal policy variables as is evident from a positive significant sign on the debt variable and a negative significant sign on the full employment surplus variable.

The hypothesis of a change in the Federal Reserve's behavior during different presidential administrations and during the administrations of two different chairman of the Board of Governors was tested by Havrilesky, Sapp and Schweitzer (1975). The period under review was 1964:1 - 1974:2. Using monthly data separate reaction functions were also estimated for various subperiods of 'easy' and 'tight' money policies (see footnote d to Table 1). The period covered the presidential administrations of Johnson (January 1964-December 1968) and Nixon (January 1969-December 1974), and the chairmanship of William McChesney Martin (1964:1 - 1970:1) and Arthur Burns (1970:1 - 1974:2). Empirical evidence confirmed the belief that the Federal Reserve responded differently to the 'state of economy' (i.e. to a movement in target variables) under the regimes of the two chairmen. The Federal Reserve responded more vigorously to price inflation during the chairmanship of Martin. Evidence also led to the conclusion that under the Nixon presidency the desired rate of unemployment rose to the 6 percent level during the 1972-74 period from the 4 percent level during the Johnson presidency.

The fiscal policy-money supply relationship has been discussed by Barro (1978) and Hamburger-Zwick (1981, H-Z hereafter) in two important papers. Barro refuted the budget deficit-money supply linkage and took the position that it is the departure of federal expenditure from normal, and not the absolute level of federal spending, that induces major changes in money growth. Empirical results also suggested counter-cyclical reactions of monetary authorities to the unemployment rate. In these equations the government expenditure variable (FEDV) is measured as the difference between the log of real federal expenditure and the log of 'normal' real federal expenditure--where the 'normal' real federal expenditure variable is a distributed (exponentially declining) lag of the log of current and real previous expenditures. The budget surplus variable [nominal federal surplus/ real trend GNP x implicit price deflator (IPD)] was rendered insignificant in the presence of the federal expenditure variable (FEDV).

H-Z used two distinct measures of government expenditures. In addition to the variable employed by Barro (FEDV), they used another expenditure variable (FED)-- nominal government expenditures divided by the GNP deflator multiplied by trend real GNP. When FED was substituted for FEDV, Barro's results did not change substantially. Together with this expenditure variable a deficit measure (DEF) was employed, where DEF is the nominal Federal deficit (national income accounts) divided by the GNP deflator multiplied by trend real GNP.

When H-Z reestimated the equation over 1961-1974, they found a dramatic reversal of Barro's results. The federal expenditure variable was found insignificant in the presence of the deficit variable. The unemployment variable turned insignificant too. Although government expenditure, rather than deficits, explained monetary growth over Barro's sample (1954-76), for a smaller sample period (1961-76), growth in the money supply was explained by federal deficits rather than by federal expenditures. This change in relationship was attributed to the higher emphasis the Fed placed on Keynesian policies beginning in the early 1960's. It led H-Z to conclude that Barro's expenditure variable was not an appropriate measure of the fiscal policy variable in the post - 1960 period, since during this period a noticeable change in the government's attitude took place. Keynesian policies were pursued more vigorously in this period, making deficits exert a stronger influence on money growth. But a re-estimation of the equation by McMillin-Beard (1982) made these results suspect. When revised data on GNP, federal expenditures and federal deficits were used for the period 1961-1974, neither Barro's nor H-Z's results were strongly supported.

Moore (1979) concluded that movement in the wage rate is the most significant variable in explaining the movement in the monetary base. Regressions were run on monthly and quarterly data. Different variable specifications included levels, first differences and percentage changes. In addition to the wage rate variable, the price variable and foreign exchange variable explained variations in the monetary base.

The coefficient on the unemployment variable had a negative sign suggesting procyclical adjustments in monetary policy. One puzzling result of the study was the negative sign on the coefficient of a contemporaneous short-term interest rate variable (though it was significant only for the quarterly data). A negative coefficient on this variable would suggest that the Fed operates monetary policy so as to reinforce the fluctuations in the short-term interest rate. This result is all the more disturbing since he took the position that the primary and overriding objective of the Federal Open Market Committee (FOMC) is to maintain the stability of the financial system. He did not make it clear as to why the Fed should strive to maintain financial market stability to the exclusion of price stability or the income-employment objective. No fiscal variable was introduced as an explanatory variable. Because of these weaknesses, the results of his study remain suspect.

McMillin-Beard (1980, M-B hereafter) estimated a reaction function as a part of a structural model for the economy. The Federal Reserve is perceived as being concerned with macro-economic stabilization and financial market stability objectives. The reaction function is derived by minimizing a quadratic loss function subject to the structure of the economy. The loss function is comprised of the squared deviations of actual from desired values of output, prices, balance of payments and interest rate. The resulting reaction function relates a monetary policy variable (unborrowed reserves) to lagged exogenous and endogenous variables and desired values of the variables in the loss function. A system of simultaneous equations representing the structure of the economy (IS-LM type econometric model) was solved for the reduced form money equation. The reaction function was estimated by regressing unborrowed reserves (adjusted for reserve requirement changes) on lagged nominal GNP (a proxy variable for several lagged endogenous and exogenous variables), nominal current government expenditures on goods and services, current exogeneous nominal federal net tax receipts, and desired values for real income, the inflation rate and the short-term interest rate. In addition to these variables, several dummy variables were used in the equation. Interaction dummy variables corresponding to different presidential administrations were included to test for any shifts in Federal Reserve behavior. For example, one interaction dummy variable, IDRYH, was given actual values of real high-employment output for the Kennedy-Johnson administration (1961:1 - 1968:4) and zero otherwise. In this fashion another interaction variable was constructed for the Nixon-Ford administration. Any change in Federal Reserve behavior during wage and price control periods was tested by including a wage and price freeze dummy variable and a post-freeze wage and price control dummy variable.

In the estimated equation, significant coefficients on the fiscal variables (a positive coefficient for government expenditure and a negative coefficient for government taxes) confirm the accommodating nature of monetary policy followed by the Federal Reserve. The interest rate coefficient was significant with the expected (negative) sign, supporting the hypothesis that the Federal Reserve manipulates the monetary policy so as to minimize the fluctuations in the short-run interest rate. The procyclical policy response of the Federal Reserve is suggested by the positive sign on the national income (proxy for aggregate demand) variable. The real high employment GNP variable was significant with the expected positive sign.

Abrams, Froyen and Waud (1980) estimated a monetary policy reaction function for the period 1970-77, using monthly data. The reaction function related a monetary policy variable (federal funds rate) to the consistent forecast of the deviation of the unemployment rate from the desired level, the rate of inflation, the surplus in the balance of the payments, the percentage effective devaluation in the foreign price of the dollar, the deviation in the money growth rate from the target growth rate, and the lagged federal funds rate. While Levy (1981) found no evidence of cyclical policy reactions, Abrams *et al*. found strong evidence of pro-cyclical measures taken by the Federal Reserve. The unemployment coefficient was significant in each specification of the reaction function with a negative sign. Mixed evidence was found on the response to the inflation variable. This variable is significant for the simplest reaction function estimated, in which the monetary aggregate and exchange rate variables were omitted. The monetary authorities also responded systematically to the exchange rate target and an average of past deviations of the growth rate in M_1 from the Fed's target rate. The Fed also tried to maintain short-term interest stability as is evident from the significant coefficient on the lagged federal funds rate. The stability of the reaction function was established by employing the random-coefficient regression technique.

Levy (1981) developed and estimated a Federal Reserve reaction function within the context of the IS-LM framework. On the basis of the estimated reaction function, he found evidence of a positive link between government deficits and the monetary base. In the estimated reaction function, the monetary base, adjusted for changes in the reserve requirement ratio, is expressed as a function of potential GNP, the lagged monetary base, short-term interest rate, inflationary expectations, publicly held debt, the unemployment rate, a time trend and seasonal dummy variables. This specification of the reaction function lacks the theoretical rigor of the M-B reaction function (1980). The reaction function was estimated in the first difference form (to avoid the problems of serial correlation) using quarterly data for the period 1952:1 to 1978:4. The estimated coefficient of the publicly held debt variable was statistically significant in explaining monetary base expansion, confirming the hypothesis of a positive money supply-budget deficit linkage. The unemployment variable was rendered insignificant in the presence of the government debt variable. The monetary authorities also reacted to changes in inflationary expectations. An increase in inflationary expectations led to an expansion in the monetary base suggesting that the monetary authorities accommodated expected inflation by expanding the monetary base. No significant response of the monetary authorities to variations in the interest rate, the unemployment rate and potential GNP was detected. The estimated reaction function was found to be unstable over the sample period on the basis of the Chow test. The change in the functional relationship over the sample period was attributed to the change in the Federal Reserve administration due to the appointment of a new Federal Reserve chairman.

Barth, Sickles, and Wiest (1982) tested the hypothesis that the

Federal Reserve's response (measured by the monthly percentage changes in the monetary base) will vary with the degree of change in economic conditions (unemployment and inflation). A general spline estimator was developed to test for the different marginal responses of the central bank to changes in inflation and the unemployment rate, depending on the initial level of these objective variables. Empirical evidence supported the hypothesis that the marginal response of the Federal Reserve does indeed vary according to the variability of economic conditions. A positive reaction of the Federal Reserve to changes in the unemployment rate and a negative reaction of the Federal Reserve to changes in the inflation rate was established. In addition, the Federal Reserve reacted positively to a change in the level of economic activity (total sales) and negatively to a change in the full employment budget surplus.

The question of a monetary policy shift over the period 1954-1980 has also been addressed by Allen and Smith (1983, A-S hereafter). The hypothesis of a structural shift in the monetary policy regime between 1959:1- 1961:4 is accepted on the basis of the Quandt and Chow test, thus lending support to the H-Z hypothesis. The deficit variable (DEBT) used by A-S is the change in net federal debt divided by the implicit price deflator times the trend value of real GNP [$\Delta NFD/P_t \cdot Y_t^*$]. They estimated the H-Z model substituting DEBT for DEF and using growth in the monetary base as the dependent variable. Quarterly data were used to estimate the equations. The entire sample period (1954:1 - 1980:4) was subdivided into several subperiods to test for a structural shift in monetary policy as suggested by H-Z and separate equations were estimated. (See footnote b accompanying Table

1.) Three different policy regimes were identified. The debt variable was positive and significant in the first two policy regimes, namely 1954:1 - 1961:2 and 1961:3 - 1969:3, while the expenditure variable (nominal government expenditure/implicit price deflator x trend real GNP) was positive and significant for the 1969:4 - 1980:4 period. Evidence suggests structural shifts in the money supply function during 1961:2 - 1961:3 and during 1969:3 - 1969:4.

The politico-economic theory of monetary expansion has been tested by Laney and Willett (1983) for the United States. According to this theory the incumbent party in any country would follow expansionary policies shortly before an election to create conditions of economic boom. After examining the data for 1960-76 they reached the conclusion that the Federal Reserve did not indulge in 'partisan politics', since no direct link could be established between the election cycle and money-supply behavior. Empirical evidence indicated that the Federal Reserve reacted in a pro-cyclical manner to the level of economic activity and in a counter-cyclical manner to the output gap. The Federal Reserve was also sensitive to the general price level, wage rate and full employment government deficit. An increase in the full-employment budget deficit exerted a positive significant influence on the money supply.

B. <u>International Studies</u>

Turning our attention to the comparative international evidence, a summary list of some previous comparative international reaction function studies is reported in Table 2. These studies are presented in chronological order. The signs on different coefficients represent the overall results of the study. Since these are comparative

Table 2. Summary List of Money Supply Reaction-Function Studies: Comparative International Studies.

No.	Study	Sample[a] Period	Regressand	Form	Lagged Regressand	W	U	D	FA	IR	IP	Q/Q*	P	Y
1	Gordon (1977)	1958:1-1973:1; Q[b] 1958:1-1976:4;Q	Money[c] Supply (M1,M2)	Growth Rate		0		-[d] +		+[e]		+[f] -	-	
2	Willett-Laney (1978)	1956-1976;A	M1	First Difference		+		0[g] +		+[h]	0			
3	Dornbusch-Fischer (1981)	1960-1977;A	M1,M2[i]	Growth Rate	+	+[j]	-	+[k] 0	+					
4	Willms (1983)	1973:1-1982:2;Q	Central Bank Money	Growth Rate			0						-	-
		1962:2-1982:2;Q	Three-month Money Market Rate	Growth Rate			0						-	0

See notes and definition of variables on pp. 26-28.

Notes:

M1 refers to the narrow money supply defined as C+D.

M2 refers to a broader definition of the money supply measured as C+D+T, where C = Currency, D = Demand Deposits and T = Time Deposits in commercial banks.

+, -, and 0 denotes respectively a positive significant sign, a negative significant sign and an insignificant sign on coefficients at the 5% level.

[a]Q denotes Quarterly, and A denotes an annual time unit.

[b]Different equations were estimated for the sample period 1958:1 - 1973:1 (i.e., for the fixed exchange rate period) and for 1958:1 - 1976:4 (which also includes a period of the floating exchange rates) to test for the structural shift in the monetary policy formulation. Countries included in the sample were the United States, Canada, France, West Germany, Italy, Japan, Sweden and the United Kingdom.

[c]Money Supply is M1 for all the countries except for Canada and France, for which it is M2.

[d]Significant for West Germany and Japan with positive coefficient.

[e]This coefficient was significant for West Germany, Japan and the United Kingdom.

[f]This coefficient was significant with a positive sign for Italy and the United Kingdom but significant with a negative sign for Japan, Sweden and France.

[g]The budget deficit variable is significant (with a positive sign) only in those equations in which the wage rate variable was omitted. When

both the wage rate and budget deficit variables were included simultaneously in the equation, the budget deficit variable was rendered insignificant.

[h]Significant for Italy but insignificant for the United Kingdom.

[i]M1 was used for South Africa and Israel, while M_2 was used for other countries in the sample - Finland, Guatemala, Ireland, Norway and Sri Lanka.

[j]This coefficient is significant with a positive sign for five out of seven countries, insignificant for Guatemala and significant with a negative sign for Norway.

[k]Mixed evidence was encountered on this variable. Positive money supply-budget deficit linkage was confirmed only for Guatemala, Israel, and Norway.

Definition of Variables:

W = Wage rate;

U = Unemployment rate;

D = Budget Deficit (Different specifications include budget deficit as a ratio of high powered money, nominal budget deficit, and a proxy variable for the full employment deficit);

FA = Change in net foreign assets as a ratio of high powered money;

IR = International Reserves;

IP = Excess of import over domestic price increases;

Q/Q^* = Output ratio, i. e., ratio of actual output (Q) to potential output (Q^*);

P = Price variable (Different specifications include tradable goods prices and the general price level);

Y = Real GNP.

international studies, there is no reason for the money supply process to be the same in all the countries. Signs in the table relate to the general conclusions of the study under review.

In a detailed study undertaken by Gordon (1977), an attempt was made to identify the source of inflation in eight industrialized countries (the United States, the United Kingdom, Japan, France, Italy, West Germany, Canada and Sweden) for the sample period of 1958:3 - 1976:4. He tested the relative strength of the variables that may cause acceleration in the money supply. These variables included the wage rate variable, the output ratio variable, the traded-goods price index, the fiscal deficit variable, international reserves, and wage dummy variables. He estimated separate equations of money growth, price growth and wage growth. On the basis of the empirical results he concluded that while no simple sub-hypothesis can precisely explain the behavior of money and prices in all the eight countries, the international monetarist hypothesis outscores the wage-push hypothesis. The wage-push hypothesis can explain the movements in wages but is not robust enough as a theory of inflation and monetary growth.

The international monetarist approach is a complex hypothesis that attributed the high rates of monetary growth outside the U.S. (in the late 60's) to developments in the U.S. that led to a high rate of growth of the money supply and prices in this country. This led to the acceleration in the money supply (and thus the prices) in other countries through four major transmission mechanisms. First, the commodity arbitrage mechanism led to the higher prices of tradable goods in other countries.[4] Second, a trade surplus would lead to higher aggregate demand in the economy, higher prices and growth in the money supply. Third, expansion in the money supply in 'other' countries would also result due to an increase in 'international reserves'. Last, inflation in the U.S. led to inflationary expectations in other countries resulting in a high wage rate and price level. Thus, a positive sign on the international reserves variable, traded goods prices variable, domestic output variable and the wage rate variable would confirm the international monetarists hypothesis. In view of this hypothesis, inflation is viewed as an international monetary phenomenon.

Mixed results were reported for the budget deficit-money supply linkage. A significant positive relationship between budget deficit and money supply was suggested by the estimated reaction functions for Japan and West Germany. The sum of coefficients and the budget deficit variable was statistically insignificant for all other countries under review. Though one or more individual significant coefficients were reported for the U.K. and U.S. (with negative sign) and for France (with postiive sign).

Dornbusch-Fischer (1981) examined the budget deficits and monetary expansion link for seven different countries for the period 1960-1977. Since they focused attention on less developed economies, countries were chosen on the basis of data availability. These countries (Finland, Guatemala, Ireland, Israel, South Africa, Sri

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[4]According to this mechanism, under the fixed exchange rate, prices of tradable goods in any country are fairly close to the world price level of tradable goods. These price increases in the tradable goods sector spread to nontradable goods, given the mobility of labor.

Lanka and Norway) cover a wide range of inflation rates (3.3 to 13.6), money growth rates (7.3 to 10.8) and budget deficits as a ratio of GNP (0.4 to 13.2). For each country, using annual time series data, they estimated a linear relationship in which the growth in the money supply is explained in terms of lagged growth rates of money, growth rates of nominal wages, unemployment rates, budget deficits (as a ratio to high powered money) and changes in net foreign assets (also a ratio to high powered money). The general fit of the equations was poor, which was attributed to a small number of observations. Estimated equations also suffered from serial correlation of residuals.

For five out of seven countries, the rate of change of wages has a positive and significant coefficient leading them to say "...this is evidence of monetary policy that accomodates wage pressures."[5] But a significant positive coefficient of wages can not be interpreted as accommodative monetary policy unless the exogeneity of wages is established, since monetarists argue that the rates of nominal wage increases reflect the past movement in the nominal money stock, just like the general rate of inflation. No significant evidence was found of a counter cyclical policy that would counteract increased unemployment by an increased money supply, since the coefficient on this variable was either insignificant (Israel, South Africa) or significant with a negative sign. Mixed evidence was found on the budget deficit-money supply relationship. For Guatemala, Israel and Norway a significantly positive budget deficit-money supply

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[5]Dornbusch and Fischer (1981), p. 333.

relationship was established while for other countries in the sample no such evidence was found.

Cost push factors as well as budget deficits were found to be major contributors to high rates of monetary expansion in the U.K. and Italy by Willet and Laney (1978). They also presented graphs establishing positive correlations among budget deficits, monetary expansion and wage increases. But none of the relationships is tight enough to draw conclusive inferences. It appears that their statistical analysis is not rigorous enough so as to enable them to make conclusive remarks on causal relationships they are trying to establish. For Britain the correlation coefficent between government deficits (D) and the index of manufacturing hourly wage rates (W) is 0.90. This high correlation coefficient contributed to the poor performance of the deficit variable when both wage and deficit variables were included as independent variables. The import price variable was insignificant for both the economies, implying that monetary expansion in both countries took place in response to domestic pressures. However, the money supply in Italy accommodated the changes in international reserves, as is evident from a significant (positive) coefficient on international reserves.

A reaction function for the Bundesbank was estimated as part of a study undertaken by Willms (1983). In the estimated reaction function perceived monetary policy instruments[6] were regressed on the inflation

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[6]Central bank money (monetary base) was used as the monetary policy instrument for 1973:1 - 1983:2, while the three-month money market rate was selected as the appropriate dependent variable over an extended sample period (1962:2 - 1982:2). The monetary base has been the announced intermediate target variable since the early 1970's, while short-term interest rates were the intermediate target variable in the earlier period.

rate, the growth rate of real GNP and the unemployment rate. Evidence indicates that the Bundesbank has primarily geared its monetary policy to attain the objective of a low inflation rate over the entire sample period (1962:2 - 1982:2). The Bundesbank was not sensitive to changes in the unemployment rate. While some evidence of countercyclical policy was found over the period 1973:1 - 1982:2, no such evidence was detected for the extended sample period.

III. General Results of the Studies

To sum up, it can be said that existing evidence relating to the reaction function of monetary authorities in different countries is mixed. For the United States the empirical evidence supports the monetarist contention. Most of the studies have reported a positive linkage between the money supply and a fiscal policy variable. Different studies have focused on different fiscal policy variables, e.g., actual deficits [H-Z (1981) M-B (1982)], government expenditure and/or above normal government expenditure [Barro (1978), H-Z (1981), A-S (1983), M-B (1982)], full employment budget surplus or deficit [Barth *et al*. (1982), Laney *et al*. (1983)], government expenditure and taxes [M-B (1980)], and government debt [Wood (1967), Levy (1981), A-S (1983)]. However, some scholars have found either no budget deficit-money supply linkage (McMillin-Beard, 1982) or a negative budget deficit-money supply linkage (Gordon, 1977).

Some support for the wage-push hypothesis has also been found. The wage-push theory of monetary accommodation was supported by Moore (1979) and Laney-Willett (1983).

Counter cyclical policy reactions were noticed by D-W (1963), Havrilesky (1967), Barro (1978), H-Z (1981), McMillin-Beard (1980), Barth _et al_. (1982) and Abrams _et al_. (1978). All these studies established empirical evidence indicating that the Federal Reserve adjusted the monetary base postively to an increase in the unemployment rate. Studies undertaken by M-B (1980) and Abrams _et al_. (1980) lend credence to the hypothesis that the Federal Reserve is concerned with the financial stability objective. Generally, the monetary authorities seem to have accommodated the demand for increased economic activity in the economy. Regression results gave the least support to the belief that the external balance goal has been a systematic determinant of monetary policy. Evidence on the price stability objective is ambiguous.

Turning to the evidence on foreign countries, it would be appropriate to say that no single hypothesis can explain the behavior of monetary authorities in different countries. Many studies failed to support the money supply-fiscal policy linkage. W-L (1978) supported the wage-push hypothesis for the United Kingdom and Italy. Willms (1983) concluded that West Germany's Bundesbank conducts its monetary policy with the primary objective of maintaining a lower inflation rate. It seems that the central banks in countries other than the United States have responded to the external balance objective. No uniform pattern has been established with respect to cyclical policies.

Scanty empirical evidence is available on the estimation of the money supply reaction function for the U.K., West Germany, and Canada. Few attempts have been made to estimate and compare the monetary policy reaction function for these countries. Out of the four studies reported in Table 2, only one study (Willms) has considered the monetary base as the monetary policy variable and that study does not include a budget deficit variable. The purpose of the present study is to contribute to and to improve upon the existing literature on the estimation of the monetary policy reaction function for the U.K., West Germany, and Canada.

The basic model underlying the time series estimation of the reaction function is presented in the next chapter.

CHAPTER III

THE MODEL

The aim of this paper is to formulate and estimate the monetary authorities' reaction function, i.e., the systematic change in the behavior of the monetary authorities as exhibited through the change in some monetary policy variable in response to the changes in macroeconomic and other variables. In this chapter the theoretical model is presented and the variables to be used in this study are specified. In the next chapter this model will be applied to test the actual behavior of the monetary authorities in the United Kingdom, West Germany, and Canada.

I. Theoretical Model

As seen in the last chapter, most previous studies have used either an explicit constrained optimization model or a reduced form approach. The reaction function in these studies is specified as a linear function of variables which are deemed theoretically or historically plausible determinants of monetary policy.

A. Formal Constrained Optimization

The formal constrained optimization approach was taken only in a

[1]See Wood (1967), Friedlaender (1973), Havrilesky, Sapp and Schweitzer (1975), and McMillin and Beard (1980).

small proportion of the studies.[1] The theoretical model of the monetary authorities' behavior was first developed by Wood (1967). Under this approach, the reaction function of the monetary authorities is explicitly derived with a constrained optimization procedure. The monetary authorities are perceived as trying to minimize a static quadratic loss function (or maximize a utility function). This is the weighted sum of squared deviations of actual from desired values of economic variables to which authorities respond. The utility or the loss function represents the authorities' preferences among alternative states of the economy, characterized by a small set of variables. This loss function is minimized subject to the constraints which are reduced form equations embodying the perceived economic structure.

The implied reaction function usually takes the form of a linear function in which the monetary policy control variable is estimated as a linear function of the goal variables measured as deviations from their optimal levels as well as exogenous variables which are included in the structural constraint equations. The coefficients of the reaction function are complex combinations of utility function weights and structural equations parameters. Therefore, no inferences can be drawn from these coefficients about the policymakers' preferences.

B. Reduced Form Reaction Function

The other, and more commonly used, approach is the reduced form approach,[2] in which no explicit optimization procedure is carried out. The monetary policy control variable is estimated as a linear function

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[2]For example see Dewald and Johnson (1963); Havrilesky (1967); Moore (1979); Barth, Sickles and Wiest (1982); and Willett and Laney (1978).

of variables which are likely determinants either in view of the past history of policymaking or are implied by economic theory. Most studies include macro-stabilization goals (e.g., low inflation, high employment, a growth objective, and a balance of payments objective) and a financial stability objective. The coefficients of the reaction function provide no direct information on the policymakers' utility function or on the weights assigned to different objectives in the utility function. It remains uncertain whether the policymakers are more concerned about inflation or employment or some other objective. The reaction function coefficients implicitly represent nonlinear combinations of loss function weights and structural parameters and cannot be used to draw any inferences about the monetary authority's preferences. The reaction function coefficients show how policymakers responded to changes in the goal variables.

II. Specification of the Model

The proposed form of the general model for central bank behavior is as follows:

$$\hat{MB}_t = f\,(\Delta r_{t-i},\ DEF_{t-i},\ \hat{W}_{t-i},\ \hat{P}_{t-i},\ I\hat{R}_{t-i},\ \Delta EEXR_{t-i},\ \Delta TB_{t-i},\ OG_{t-i}) \qquad (3.1)$$

where:

$\hat{MB}$ = Quarterly rate of change of monetary base,

Δr = Quarterly changes in interest rate,

DEF = Budget deficit variable,

$\hat{W}$ = Quarterly rate of change in wages,

$\hat{P}$ = Quarterly rate of change in prices,

$I\mathring{R}$ = Quarterly rate of change in international reserves,

$\Delta EEXR$ = Quarterly changes in effective exchange rate,

ΔTB = Quarterly changes in trade balance,

OG = Output gap,

subscript t refers to the time period under consideration, and subscript i indicates the lag length. Both the contemporaneous and lagged (when applicable) values of the explanatory variables are employed.

The money supply reaction function specified here represents the reduced form reaction function, implicitly derived from a larger structural model. As noted before the estimated coefficients of the reduced form reaction function do not provide direct information on the priorities of the monetary authorities. However, the estimated coefficients help in ascertaining determinants of the money supply in countries operating under different monetary and political regimes. The form in which variables enter the equation and the expected sign on the coefficients are discussed below.

The monetary base has been chosen as the monetary policy variable since it serves as a more appropriate dependent variable than the money supply (defined narrowly or broadly). Changes in the money supply can take place without accommodative reactions from central banking authorities to an increase in the sale of government securities to finance a budget deficit or to the other variables to the extent that these variables also alter economic variables that in turn lead to changes in the money supply. The deficit will lead to higher short-term interest rates, which can induce an increase in the supply of money through changes in private sector responses.

Therefore, even in the face of nonaccommodative policies by the central bank, the money supply may increase because of a reduction in the ratio of excess reserves/demand deposits and time deposits/demand deposits. Thus, the regression coefficient of budget deficits on the money supply will incorporate the influence of these private sector responses as well as central bank responses. To isolate the central bank responses, if any, to changes in budget deficits and other macro economic variables, the appropriate dependent variable is the monetary base rather than the money supply.

Moreover, in an international study, use of a standardized dependent variable is appropriate. Currently, different countries focus on different concepts of the money supply because of the different levels of development of financial markets and availability of near-money substitutes. New innovations in financial markets bring forth new financial instruments which are close substitutes for traditionally defined money. For example, Negotiable Orders of Withdrawal (NOW) are a close substitute for checking and saving deposits.[3] These near-monies should be included in a comprehensive definition of the money supply. Thus, different levels of development of financial markets would warrant different definitions of the money supply.[4] The monetary base, on the other hand, is applicable to different financial and institutional structures. The monetary base

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[3] In the U.S. NOW accounts are included in M1.

[4] The issue of defining money has not been settled even at the theoretical level. There are some subtle issues in defining money, and it is not clear that all near monies (like passbook savings, unused credit facilities) should be included in all definitions of money.

has been used as a dependent variable in studies undertaken by Barth, Sickles and Wiest (1982), Froyen (1974), Levy (1981), and others. The quarterly rate of growth of the monetary base [Log (MB_t/MB_{t-1})] is the dependent variable used in the estimated reaction functions in this study.

The interest rate variable used in estimation is the quarterly change in the three-month Treasury bill rate $(TBR_t - TBR_{t-1})$. A positive coefficient is expected on the interest rate variable stressing the interest rate stability concern of the monetary authorities. The monetary authorities would like to stabilize the interest rates at low levels, so that an increase in the interest rate may induce the monetary authorities to pursue expansionary monetary policies aimed at bringing interest rates down. A short-term interest rate measure is favored as opposed to a long-term interest rate because it appears more likely that central banks would monitor the fluctuations in short-term rates.[5]

The fiscal policy variable, the government deficit (or surplus), has been used in different forms in different studies. Willett and Laney (1978) used the actual government deficit while the ratio of the budget deficit to high powered money was used in the money growth function estimated by Dornbusch and Fischer (1981). Gordon (1977) used the fiscal-deficit residual variable in the money growth equation. To obtain this residual variable, the fiscal-deficit ratio

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[5]As Levy (1981) points out, "The 3-month treasury-bill rate rather than a long run interest rate is used because it is a better indicator of the cost of government borrowing (a growing portion of the debt is financed through short-term debt issues)" p. 357. It is not clear, however, whether this is true for the countries under study.

was constructed by dividing the nominal deficit of the central government by the nominal gross national product. This ratio was regressed on a constant, three seasonal dummies, and the real output ratio (current and lagged one period). The level of residuals from this equation was entered into the money equation.

In the present study we have experimented with alternative specifications of the government deficit variable. Alternative specifications of the budget deficit variable include de-trended budget deficits and de-trended changes in government debt. To de-trend the budget deficit, the ratio of the actual real budget deficit to the trend value of real GNP is taken. To construct a series for trend real GNP, real GNP is regressed on a constant and time variable (both linear and polynomial). The predicted GNP values from this equation are used as a measure of trend real GNP. The nominal budget deficit is then divided by the product of the GNP deflator and the trend value of real GNP. An analogous measure of the fiscal policy variable has been used by Barro (1977, 1978), Hamburger and Zwick (1981), and Allen and Smith (1983). De-trended changes in government debt are computed by dividing the quarterly change in the nominal government debt by the product of the GNP deflator and the trend value of real GNP.

A positive coefficient on the budget deficit variable will confirm a positive budget deficit-money supply linkage. An increase in government expenditures (or the budget deficit) will push up the market interest rate, if the real money supply is held constant. The central bank, in an effort to dampen the interest rate, will increase the money supply to offset part or all of the increase in the interest rate. But this positive linkage may not be observed if the central bank's concern for other goals (e.g., the price stability objective) is greater than its concern for financial market stability. An increase in government expenditure will result in a higher level of aggregate demand and a higher price level. The monetary authority may respond to the higher prices by adopting a restrictive monetary policy.

Following Gordon (1977), Willett and Laney (1978), and Dornbusch and Fischer (1977) the quarterly growth rate of nominal wages [log (W_t/W_{t-1})] has been introduced in the money growth equation to test for the wage push hypothesis. Adherents of the wage-push hypothesis blame wage acceleration for monetary expansion. According to Dornbusch- Fischer (1981, pp. 330-331) "... increased wage inflation requires an accommodating monetary expansion. There is a question whether monetary accommodation is full or only partial. In the former case increased wage inflation leads to higher inflation and no decrease in output, while in the latter case the output effect is negative. This case is less likely in that the central bank will typically have both inflation and employment targets." Increases in wages, if not accommodated by monetary expansion, will put a squeeze on profits and lead to increased unemployment and reduced output. The response of monetary authorities to these economic variables may take the form of monetary expansion. A positive sign on the wage coefficient will confirm the direct money supply-wage increase linkage.

The inflation rate variable [log (P_t/P_{t-1})], the quarterly rate of change in the consumer price index, reflects the price stability objective of the central bank. The expected sign of the coefficient on the inflation variable is negative, since any inflationary pressure in the economy may be countered by contractionary monetary policies.[6] The coefficient may be less than minus unity because monetary authorities are aware of the fact that contractionary policies may result in higher short-run unemployment.

The output gap, the output ratio, and the unemployment variable are the alternative variables employed to test for the cyclical reactions of the monetary authority. The deviations between actual and trend GNP are used as a proxy for the output gap. To attain trend real GNP, real GNP is regressed on a constant and a trend variable, i.e. equations of the following form are estimated:

$$GNP = C + T + u_{1t} \tag{3.2}$$

$$GNP = C + T + T^2 + u_{2t} \tag{3.3}$$

Equations (3.2) and (3.3) test for the existence of a linear trend versus a polynomial trend. The equation giving the best fit is picked. Predicted GNP from the chosen equation is used as a proxy for the trend GNP. The output gap as a percentage of trend real GNP is calculated as follows:

$$\text{Output Gap} = \left(\frac{\text{Actual real GNP - Trend real GNP}}{\text{Trend real GNP}} \right) \times 100 \tag{3.4}$$

[6]Implicit in the argument is the assumption that the desired inflation rate is zero.

It is entered in level form in the money growth equation. In addition, 'output ratio' (Q/Q^*) has also been used as a proxy for the effects of real output and labor market conditions in the money equation (where Q is actual output and Q^* is potential real output). This measure was suggested and used by Gordon (1977) in the money growth equation. Alternatively, quarterly changes in the unemployment rate have been used as an explanatory variable to test the cyclical response of the monetary authority.

A positive sign on the domestic output coefficient would confirm the pro-cyclical reaction of the monetary authorities, since an increase in domestic output would lead to increased money demand and thus to an increased money supply. A negative sign on the output coefficient or a positive sign on unemployment variable would support a counter-cyclical reaction of the monetary authorities. A positive coefficient on the unemployment variable can be interpreted as the countercyclical reaction of the monetary authority, since an increase in unemployment (or a decrease in the level of economic activity) is countered by an expansionary monetary policy.

The money supply process in any open economy is also influenced by the balance of payments situation. The balance of payments situation has a direct impact on the money stock under fixed exchange rates. The monetary base of the economy is equal to the sum of domestic credit and net foreign assets of the central bank. A balance of payments surplus would lead to an increase in the net foreign assets, thus expanding the monetary base, unless the changes in the foreign assets are sterilized by the monetary authorities through offsetting movements in domestic credit. To test for this, the quarterly change in international reserves ($IR_t - IR_{t-1}$) and the quarterly rate of change of international reserves [$\log(IR_t/IR_{t-1})$] have been used as alternative explanatory variables, the expected sign of the coefficient being positive. However, the possibility of the absence of a positive sign on international reserves can not be ruled out. If the monetary authorities can successfully sterilize the movements in foreign assets by varying domestic credit, the coefficient on international reserves may be statistically insignificant.

To detect any changes in the behavior of the monetary authorities in the floating exchange rate period (1973 onwards), Gordon estimated two sets of money growth equations, one for the period 1958:3 to 1973:1 (basic equation) and the other for the period 1958:3-1976:4 (auxiliary equation). The auxiliary equation includes an additional variable, the rate of change of the exchange rate between each country and the U.S. dollar. This variable is entered as a multiplicative dummy assuming a zero value through 1973:1 and positive values thereafter. A shift in the coefficients between the basic and auxiliary equations was attributed to the changed structure of the money supply process under the flexible exchange rate period. Abrams, Froyen and Waud (1980) have used the balance of payments surplus in conjunction with effective dollar devaluation as explanatory variables.

In this study, in addition to an international reserve variable, quarterly changes in the index of bilateral exchange rate (i.e., the exchange rate between the currency in question and the U.S. dollar) and quarterly changes in the index of effective exchange rate are used as alternative specifications of the exchange rate variable. The latter is an index combining the exchange rates between the currency in question and other major currencies.[7] The index of the effective exchange rate is given values equal to zero for the fixed exchange rate period and equal to itself for the floating exchange rate period (since this measure is available only for the floating exchange rate period). Finally, two other international variables are tested--quarterly changes in the current account of the balance of payments and the quarterly changes in the net trade account of the balance of payments. The expected sign on these variables is positive, since an increase in the balance of payments surplus may cause an expansion in the monetary base.

III. Method of Econometric Estimation

The general practice in the studies summarized in Chapter II is to use the same lag length on all the explanatory variables.[8] Since there is no a-priori reason to impose the same lag length on all the explanatory variables, the Final Prediction Error (FPE) test [Hsiao, 1981] has been used to determine the lag length on each explanatory variable separately. The use of this procedure allows the data to determine the lag length.

Hsiao (1981) suggests a step-wise procedure to determine the lag length on different exogeneous variables in a multivariate model.

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[7]Other currencies are assigned weights which in turn are derived from the Multilateral Exchange Rate Model (MERM) developed by the IMF. This model assigns weights in accordance to the size of flows as well as of the relevant price elasticities and the feedback effects of exchange rate changes on domestic costs and prices.

[8]Gordon (1977) used three lagged dependent and independent variables in the money equation.

This procedure is based on Granger's concept of causality and Akiake's final prediction error (FPE) criterion. Using this step-wise procedure, a different lag length can be determined for each of the right hand side variables of a multivariate equation.

Since the lag length on each variable is determined by the data, the FPE procedure avoids any bias due to underspecification of lags on a variable(s) when a common lag length is employed. According to Caines _et al_. (1981, p. 269) "The minimum FPE criterion is equivalent to applying an approximate F-test with varying significance levels". To specify the order in which the right hand side variables enter the equation, the Specific Gravity Criterion of Caines, Keng and Sethi (1981) is used.[9] Details of the estimation procedure are given below.

1. In the first step, the optimum lag length is determined on each of the explanatory variables (one at a time). For this purpose bivariate equations of the following form are estimated:

$$M\hat{B}_t = C + \sum_{n=0}^{N} \alpha_n X_{t-n} + e_t \qquad (3.5)$$

where:

C = constant,

X = independent variables (taken one at a time),

MB = monetary base,

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[9]Akiake's final prediction error test in conjunction with Caines' _et al_. (1981) specific gravity test is used by McMillin (1985) to examine the budget deficit-money supply linkage in a multivariable equation.

N = highest order lag,

subscript t stands for time, and

e = error term.

The order of the lag is varied in each bivariate equation. For each bivariate equation the FPE is calculated using the following formula:

$$FPE_{(n)} = \frac{T + n + 1}{T - n - 1} \cdot \frac{SSR(n)}{T} \tag{3.6}$$

where T is the number of observations actually used in estimating the bivariate equation, n stands for the order of the lag and SSR denotes sum of squared residuals. The lag length that yields the minimum FPE is then selected as the appropriate lag length. According to Hsiao (1981), the use of the minimum FPE criterion is analogous to the application of an F-test with varying significance levels. As noted by Judge <u>et al</u>. (1982) and Hsiao (1981), the FPE criterion is intuitively appealing because an increase in the number of lags will lead to an increase in the first term but would decrease SSR and thus the second term on the right hand side in equation (3.6). The minimum FPE is recorded when these two opposing forces are balanced.

In this manner, using the bivariate equation models, a lag length yielding the minimum FPE is selected for each explanatory variable. A problem encountered here, however, is determining the order in which explanatory variables enter the equation. The specific gravity criterion of Caines, Keng and Sethi (1981) is used to ascertain which one of the explanatory variables should enter the money growth equation first, with the chosen number of lags. The specific gravity of the causal variable X with respect to the caused variable $\dot{MB}$ is the reciprocal of the minimum final prediction error. Explanatory variables are ranked in the descending order of the specific gravity. Specific gravities of the causal variable with respect to the caused variable indicate the relative importance of the explanatory variables in explaining the movements in the endogenous (policy) variables.

2. In the second step, the causal variable with the highest specific gravity is chosen as the first explanatory variable entering the equation with predetermined lag length. Then, this variable is treated as a controlled variable, with given lag length, and a trivariate equation of the following form is estimated:

$$\dot{MB}_t = \alpha_0 + \sum_{i=0}^{I} \alpha_i Y_{t-i} + \sum_{n=0}^{N} \alpha_n X_{t-n} + e_t \qquad (3.7)$$

Here Y is the controlled variable, i.e., the first variable chosen to enter the equation on the basis of the specific gravity criterion described in step 1; I is the predetermined order of the lag on variable Y (i.e., the lag length yielding minimum FPE); N is the maximum number of quarters over which the appropriate lag length is searched for each variable; and X stands for other causal variables (taken one at a time). In the trivariate equations the lag length is varied on variable X and the appropriate lag length is selected on the basis of the FPE test. This procedure is repeated for every explanatory variable (other than the controlled variable Y) and then variables are ranked in order of decreasing specific gravity. The one with the highest specific gravity enters the equation in second place with the lag length determined by minimum FPE.

3. In the third step, four-variable models are estimated, with two controlled variables (with predetermined lags) and other explanatory variables entering as manipulated variables, with varying lag length (considered one at a time). As described in steps one and two above, the appropriate lag length is chosen on each of the manipulated explanatory variables. Variables are ranked in descending order of specific gravity and the one with the highest specific gravity is added to the equation with appropriate lag length. The same procedure is repeated until all the explanatory variables are added to the equation with the specified lag length.

The search for the optimum lag length for each causal variable is carried out over the identical sample period. The maximum number of lags tried for each variable is also the same. The FPE criterion would facilitate entering each variable with a different order of lag, a lag length that is determined by the information contained in the sample and is not imposed in an arbitrary manner. The use of the specific gravity criterion makes possible a different specification of the reaction function for the monetary authorities in different countries. Once the optimum lag length is determined on each explanatory variable, along with the order in which explanatory variables enter the equation, reaction functions are estimated using the OLS and the instrumental variables (IV) techniques. IV is adopted to avoid any inconsistent parameter estimates due to a possible feedback between the explained variable (monetary base) and the contemporaneous values of the explanatory variables (e.g., interest rate, price index, budget deficit or wage rate). The resulting coefficient estimates will be asymptotically consistent. If preliminary results suggest the presence of serial correlation among residuals, OLS and IV estimates are obtained using the Cochrane-Orcutt iterative procedure. Restricted versions of reaction functions are also estimated after dropping statistically insignificant variables from the fully specified reaction function.

The next step is to estimate econometrically the theoretical model presented in this chapter, using the FPE and the Specific Gravity criteria. Estimation results are reported in the next chapter.

CHAPTER IV

ESTIMATED REACTION FUNCTIONS

The general model underlying the time series estimation of the reaction function was developed in Chapter III. As described there, the reaction function of the individual countries and the order of the lag on explanatory variables are specified with the help of a sequential procedure using Caines' *et al*. (1981) specific gravity criterion and Hsiao's (1981) FPE criterion. The estimation results for the United Kingdom, West Germany, and Canada are reported in this chapter. It consists of three sections. The first section presents the estimated reaction function for the central bank in the United Kingdom. Estimated reaction functions for West Germany and Canada are discussed in sections II and III respectively.

All the equations are estimated using quarterly data over the identical sample period (1960:2 - 1983:4).[1] The starting date for the sample is determined by the starting date of the data file (1957:1) and by the maximum number of quarters over which the appropriate lag length is searched (12 quarters). The maximum time period over which the lag length is searched is twelve quarters, since this time period is considered to be long enough to detect any response of the monetary authorities to changes in economic and other variables.

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[1]Models have been estimated using the T.S.P. (Time Series Processor) package, Version 4.0.

Reaction functions are estimated by regressing a monetary policy variable (quarterly rate of change in the monetary base) on explanatory variables representing different concerns of monetary authorities. For some explanatory variables, alternative specifications have been used in order to identify the most appropriate form of the explanatory variables. For example, the detrended budget surplus (SUR) variable and the detrended government debt (DEBT) variable are tried alternatively to test for a fiscal policy-monetary policy linkage.[2] The output ratio (OR), the output gap (OG) and the unemployment variable (ΔUN) test the monetary authorities' concern about cyclical fluctuations in the economy. The exchange rate variable, the international reserves variable, and the balance of payments variable are proxies employed for the external balance objective. Different specifications of the exchange rate variable include quarterly changes in the bilateral exchange rate (ΔEXR) (between the currency in question and the U.S. dollar) and quarterly changes in the effective exchange rate (ΔEEXR, defined on pp. 45-46). Two alternative specifications are used for the international reserves variable--quarterly changes in international reserves (ΔIR) and the quarterly rate of change of international reserves ($\dot{IR}$). Two alternative variables used to test the reaction of monetary authorities to changes in balance of payments are quarterly changes in the current account of the balance of payments (ΔBOPCB) and quarterly changes in the trade balance (ΔTB).

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[2]The government debt variable has not been used for the United Kingdom due to the lack of complete data files.

Reaction functions are estimated using OLS and the instrumental variable (IV) technique. If preliminary results suggest the presence of serial correlation among residuals, OLS and IV equations are estimated using the Cochrane-Orcutt iterative procedure. In the case of IV estimation, with a serial correlation correction, the lagged dependent variable has been added to the list of instrumental variables, since Fair (1970) has shown that the lagged dependent and independent variables must be included in this list to ensure consistent estimates.

I. United Kingdom

Tables 4-11 determine the basic form of the linear reaction function for the United Kingdom. Variables used in Table 4-13 are defined in Table 3. In addition to the other explanatory variables, a constant term and three seasonal dummies have been added to each equation. Table 4 reports the results of the equations having the following form:

$$\dot{MB}_t = C + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \sum_{n=0}^{N} \beta_n X_{t-n} \qquad (4.1)$$

where D_1, D_2, and D_3 denote three seasonal dummies, and X denotes other explanatory variables (taken one at a time). $\dot{MB}$ stands for the growth rate of the monetary base, subscripts t and n refer to the time period under consideration and lag length respectively. N is the highest order of the lag considered (12 quarters). For each causal variable, separate equations are estimated with varying lag lengths. The lag length is varied from 0 to 12 (thus for every causal variable thirteen equations are estimated). For every equation the FPE was computed. The minimum FPE for every causal variable and the associated lag length (in quarters) is reported in Table 4. Variables are then ranked in descending order of specific gravity, where specific gravity is computed as 1/FPE. From these bivariate models, on the basis of the specific gravity criterion, the quarterly rate of growth of international reserves is chosen as the first variable to enter the money growth equation, with lag length of one quarter. This variable would not have been preferred if the adjusted coefficient of determination (adjusted for degrees of freedom) was the sole criterion for determining the order in which the right hand side variables enter the regression equation. Results presented in Table 4 also suggest that for the international reserves variable, the quarterly rate of growth ($I\mathring{R}$) is a better specification than quarterly changes (ΔIR), since a lower value of the minimum FPE is recorded for the former.

In the next step, the international reserves variable ($I\mathring{R}$) is treated as a controlled variable with one quarter lag length (see Table 5). All other causal variables are coupled with $I\mathring{R}$ with varying lag lengths, i.e., the linear equation in the following form is estimated:

$$M\mathring{B}_t = C + \alpha_1 D_1 + \alpha_2 D_2 + \alpha_3 D_3 + \sum_{k=0}^{1} a_{1k}\, I\mathring{R}_{t-k} + \sum_{n=0}^{N} \beta_n\, X_{t-n} \qquad (4.2)$$

where D_1, D_2, D_3 and $I\mathring{R}$ denote three seasonal dummies and the international reserves variable, and X denotes other explanatory variables (taken one at a time). The international reserves variable is treated as a controlled variable and enters every equation with a fixed lag length (determined in the previous step), while the lag length on all the other causal (manipulated) variables is varied from 0 to 12 quarters in different equations. In Table 5, the minimum FPE for different trivariate equations and corresponding lag lengths are reported. Causal variables are arranged in descending order of the specific gravity. On the basis of the specific gravity criterion, quarterly changes in the index of effective exchange rate enters the money growth function in the second place. For this variable the minimum FPE was recorded for a lag length of two quarters. Thus, the effective exchange rate variable is added to the equation with a lag length of two quarters.

The same procedure is repeated to determine the order of other causal variables in the money growth equation. The FPE and the specific gravity criteria are used in Tables 4-11 to determine the lag length on different explanatory variables, the proper specification of the variable, and the order in which the right hand side variables enter the money growth equation. From this stepwise procedure, the basic model of the following form is specified[3,4]:

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k} \, \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k} \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k} \, SUR_{t-k} +$$

$$a_4 \, \Delta UN_t + \sum_{k=0}^{4} a_{5k} \, \Delta r_{t-k} + \sum_{k=0}^{4} a_{6k} \, \dot{W}_{t-k} + \sum_{k=0}^{4} a_{7k} \, \Delta BOPCB_{t-k} + a_8 \dot{P}_t \quad (4.3)$$

[3]See Table 3 for definition of variables.

[4]An alternative measure of the fiscal variable gave the same results. Following Gordon's (1977) procedure, the fiscal-surplus residual variable was constructed by regressing the fiscal-surplus ratio (i.e., the ratio of the nominal actual surplus and nominal GNP) on a constant, three seasonal dummies and the current and lagged ratio of real GNP to trend real GNP. The level of residuals from this equation was entered into the money equation. The minimum FPE (.00146) occurred at the lag length of six quarters.

The model presented in equation (4.3) was first estimated with OLS procedure. The D-W statistic for this equation was 2.34. Due to the large number of regressors, the D-W bounds test could not be performed.[5] However, the possibility of the first-order negative correlation among residuals could not be ruled out. Thus, to check for serial correlation, the Box-Pierce Q statistic was computed.[6] The estimated value of the Q-statistic for this equation was 3.06 for the first-order serial correlation. The tabulated value of χ^2 at the 5% level of significance is .0039 (for 1 d.o.f.). Since the calculated statistic is higher than the tabulated value, null hypothesis of no first-order serial correlation was rejected at the 5 percent level. Since the presence of the autocorrelation results in inefficient OLS parameter estimates, the Cochrane-Orcutt iterative procedure is used to correct for first order serial correlation.

Table 12 presents the estimated reaction function of the monetary authorities of the United Kingdom for the sample period 1960:2 - 1983:4. Equation (12.1) has the form of the basic model specified in equation (4.3) on the basis of the final prediction error test and the specific gravity criterion. OLS estimates in equation (12.1) are obtained by the Cochrane-Orcutt (C-O) method. The D-W statistic indicates the absence of any further first order serial correlation.

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[5]The available tables for the D-W bounds test are restricted to 21 regressors (including the constant term). Since the number of regressors in this estimated equation (not reported) was 32, the D-W bounds test could not be performed.

[6]Q statistic was first suggested by Box and Pierce (1970). It is approximately distributed as X^2 (Chi-square) with K degrees of freedom where K refers to the number of autocorrelations.

The Q-statistic for the first-order serial correlation for equation (12.1) is .00000055. Since the estimated value of the Q statistic is lower than the tabulated value of $\chi^2_{(1)}$ (.0039), the null hypothesis of no further first-order serial correlation [i.e., Ho: $\rho_1 = \rho_2 = \ldots \rho_k = 0$] cannot be rejected. In equation (12.1) the sums of coefficients on the effective exchange rate variable (a_2) and the unemployment variable (a_4) are statistically significant. While for other explanatory variables the sums of the coefficients were insignificant, some individual significant coefficients were observed. Since the estimated equation suggests that variations in the price level do not explain the permanent or the temporary adjustments in the behavior of the monetary authority, the reaction function was reestimated after dropping the price variable. It should be noted that the other explanatory variables with insignificant sum of the coefficients are retained in the estimated equation, because some significant individual coefficients were observed for these variables. The estimation results for this restricted model are reported in equation (12.2).

When the price inflation variable is dropped, the estimated reaction function (12.2) registers a sign reversal on the sum of coefficients of the short-term interest rate variable a_5, even though it is statistically insignificant. The coefficient on the unemployment variable (a_4) remains significant at the 5% level with a negative sign. A negative coefficient on the unemployment variable indicates the procyclical reactions of the monetary authority. For every percentage point increase in the unemployment rate, the growth rate of the monetary base decreased by .036% by the end of that quarter (equation 12.2). The sum of coefficients on the effective exchange rate variable is signficant in both OLS equations [(12.1) and (12.2)] at the 5% level of significance with a positive sign. The positive coefficient on the effective exchange rate variable indicates an expansionary effect of this variable on the $\mathring{MB}$. For every percentage point increase in the index of the effective exchange rate sustained over a period of three quarters, $\mathring{MB}$ increased by .0009% by the end of the third quarter. The sums of coefficients on all other variables are statistically insignificant suggesting that these economic variables do not have any permanent influence on monetary policy after all the temporary adjustments have taken place.

To avoid any inefficient parameter estimates due to endogeneity among contemporaneous values of the explanatory variables, the reaction function is reestimated using the instrumental variable technique with first order serial correlation correction. Cochrane-Orcutt (C-O) iterative procedure for serial correlation correction is combined with an instrumental variable procedure. A time trend variable, detrended government expenditures (current and three lagged values) and one additional lag on each explanatory variable were used as instrumental variables. In addition to these instrumental variables, the lagged dependent variable ($\mathring{MB}_{t-1}$) has been used as an instrument. A lagged dependent variable has been added to the list of the instrumental variables, since Fair (1970) has shown that the inclusion of the lagged dependent and independent variables, in the instrument list, results in the consistent parameter estimates in the case of the IV estimation with a serial correlation correction. Results are reported in equation (12.3 and 12.4). Equation (12.3) reports the results of the model specified in equation (4.3), while equation (12.4) presents the estimated parameters of a restricted model in which the price variable, the balance of payments variable, and the wage rate variable have been dropped. A decision to drop these variables was made after analyzing their individual coefficients (contemporaneous and lagged). In addition to insignificant sums of coefficients, these variables exhibited all insignificant individual coefficients, suggesting that variations in these variables do not affect the behavior of the monetary authority in the U.K. systematically or temporarily.

With the use of the instrumental variable technique, t-statistics for the sum of coefficients on the unemployment variable registered a sharp decline (12.3) and (12.4). Significant changes in the results are observed with the use of the instrumental variable technique. A comparision of equations (12.1) and (12.3) indicates that the coefficient on the unemployment variable (a_4) and the sum of coefficients on the effective exchange rate variable (a_2) are no longer significant. The t-statistic for all other variables remains insignificant, and a sign reversal on the sum of coefficients on the short-term interest rate variable (a_5) and on the balance of payments variable (a_7) is observed. For all other variables the sign remains the same and the sum of coefficients registers an increase or a decrease. A comparision of the two restricted models, [i.e., (12.2) and (12.4)] also suggests a similar pattern of changes in the results. The coefficient on the unemployment variable is no longer significant and the sum of coefficients on the effective exchange rate variable is only marginally significant (at the 10% level) in equation (12.4).

For all other variables, while the sign remains the same, the sum of coefficients and the corresponding t-values register an increase or a decrease.[7]

These results suggest that only variations in the effective exchange rate variable have a systematic impact on monetary policy in the U.K. As seen in Table 13 a one percent increase in the index of the effective exchange rate led to a .0005% increase in the MB in the same period (t), a .0006% increase in the MB in the next quarter and a .0007% increase in the MB in the third quarter (t+2). Only the last coefficient is significant at the 10% level. However, by the end of the third quarter, a sustained one percent increase in the effective exchange rate was associated with a .0018% increase in the growth rate of the monetary base, though this coefficient is marginally significant at the 10% level.

While no lasting impact of other economic variables on monetary policy is detected, an analysis of the individual coefficients on these variables is warranted in order to detect the temporary influences, if any. An analysis of Table 13 shows that in the short-run some of these variables do influence monetary policy.

The sums of coefficients on the fiscal-policy variable (a_3) and the interest rate variable (a_5) are statistically insignificant, but

[7]These results were sensitive to the list of the instrumental variables used in estimation. When (12.4) was reestimated using exactly the same set of instrumental variables as equation (12.3) (i.e., five lagged values for the wage rate variable, balance of payments variables and one lagged value for the price variable were not dropped from the set of instrumental variables), the sums of coefficients on the effective exchange rate variable (a_2) and the budget surplus variable (a_3) were statistically significant at the 5% level. The sum of coefficients on all explanatory variables had the same sign.

these variables made some temporary contributions to the monetary policy in the U.K. as is evident from the individual lagged coefficients on these variables (Table 13). One lagged coefficient on the fiscal policy variable is significant. Individual lagged coefficients on the budget surplus variable reveal the oscillatory reaction patterns of the monetary authority. An increase in the ratio of the real budget surplus to real trend GNP of 1% led to a decrease of 1.77% in the $\dot{MB}$ in the seventh quarter (t+6).

One lagged coefficient on the short-term interest rate variable (t-4) is statistically significant. It shows the delayed response of the monetary authority to variations in the short-term interest rate. For every percentage point increase in the short-term interest rate (r), the growth rate of the monetary base increased by .007% during the fifth quarter (t+4), provided r remains at the new level for the next four quarters. This result suggests that the monetary authority responded only with a long lag to a disturbance in the financial sector.

In summation, the estimated equations establish the effective exchange rate variable as a systematic determinant of monetary policy in the U.K. While other economic variables had no lasting impact on monetary policy, interim adjustments in the monetary base took place in response to changes in the budget surplus and the short-term interest rate.

Table 3. Definition of Variables: United Kingdom

$\dot{MB}_t$	=	Quarterly rate of change of the monetary base, period t.
$\dot{IR}_t$	=	Quarterly rate of change of international reserves, period t.
ΔIR_t	=	Quarterly changes in international reserves, period t.
SUR_t	=	Detrended budget surplus, $\left(\frac{\text{Nominal budget surplus}}{\text{Trend real GNP x } \frac{IPD}{100}}\right)$, period t.
$\Delta EEXR_t$	=	Quarterly changes in the index of the effective exchange rate, period t.
ΔEXR_t	=	Quarterly changes in the index of bilateral exchange rate, period t.
$\dot{W}_t$	=	Quarterly rate of change in wages, period t.
Δr_t	=	Quarterly changes in short-term interest rate, period t.
ΔUN_t	=	Quarterly changes in the unemployment rate, period t.
OR_t	=	Output ratio, period t.
OG_t	=	Output gap, period t.
$\dot{P}_t$	=	Quarterly rate of change in prices, period t.
ΔTB_t	=	Quarterly changes in trade balance, period t.
$\Delta BOPCB_t$	=	Quarterly changes in balance of payments, current balance, period t.

Table 4. Determination of Lag Length and Specific Gravity of Manipulated Variables in Bivariate Equations: United Kingdom.

$$\hat{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Manipulated Variable	Minimum FPE	Lag Length	R^2	Specific Gravity
$\hat{IR}$	.00144442	1	.609381	694.44
ΔIR	.00153847	0	.579785	649.99
SUR	.00146141	6	.623429	684.93
$\Delta EEXR$	.00146584	2	.607473	680.27
ΔEXR	.00155811	0	.574421	641.80
$\hat{W}$	.00147918	1	.599980	675.68
Δr	.00149545	0	.591536	666.67
ΔUN	.00151112	0	.587255	661.76
OR	.00155515	0	.575230	643.02
OG	.00155872	0	.574255	641.03
$\hat{P}$	.00154853	1	.581225	645.16
$\Delta BOPCB$	.00155013	0	.576599	645.11
ΔTB	.00155959	0	.574016	641.19

Variables are defined in Table 3.

All equations have the functional form given at the top of this table.

Table 5. Determination of Lag Length and Specific Gravity of Manipulated Variables in Trivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\, \dot{IR}_{t-k} + \sum_{n=0}^{12} \beta_n\, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(1)$					
	ΔEEXR	.00135652	2	.643733	736.920
	ΔEXR	.00147490	0	.605049	678.012
	$\dot{W}$	.00136324	1	.638491	733.676
	SUR	.00137372	6	.652578	727.802
	ΔUN	.00141701	0	.620549	705.711
	OG	.00147426	0	.605220	678.426
	OR	.00147449	0	.605157	678.201
	$\dot{P}$	.00145470	1	.614240	687.285
	Δr	.00146529	0	.607620	682.594
	ΔBOPCB	.00145665	0	.609935	686.507
	ΔTB	.00146267	0	.608322	683.681

[a]The number in parentheses beside the controlled variable is the optimal order of the lag (in quarters).

Variables are defined in Table 3.

All equations have the functional form given at the top of this table.

Table 6. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\, \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k}\, \Delta EEXR_{t-k} + \sum_{n=0}^{12} \beta_n\, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(1)$					
$\Delta EEXR(2)$					
	SUR	.00120883	6	.702543	827.267
	$\dot{W}$	.00130248	1	.664380	767.754
	ΔUN	.00134979	0	.648876	740.856
	OR	.00137416	0	.642538	727.717
	OG	.00138567	0	.639543	721.657
	$\Delta BOPCB$	.00137034	0	.643531	729.746
	ΔTB	.00137522	0	.642263	727.156
	$\dot{P}$	.00137435	1	.645861	727.590
	Δr	.00137862	4	.654537	725.374

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 3.

All equations have the functional form given at the top of this table.

Table 7. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\, \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k}\, \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k}\, SUR_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	R^2	Specific Gravity
$\dot{IR}(1)$					
$\Delta EEXR(2)$					
SUR(6)					
	ΔUN	.00116905	0	.714900	855.395
	OR	.00121040	0	.704815	830.565
	OG	.00121547	1	.706206	822.707
	Δr	.00119487	4	.718651	836.890
	$\dot{W}$	.00121051	0	.704789	826.105
	$\Delta BOPCB$	.00123001	0	.700032	813.002
	ΔTB	.00123506	0	.698802	809.677
	$\dot{P}$	.00123460	0	.698913	809.979

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 3.

All equations have the functional form given at the top of this table.

Table 8. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\ \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k}\ \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k}\ SUR_{t-k} +$$

$$a_4\ \Delta UN_t + \sum_{n=0}^{12} \beta_n\ X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(1)$					
$\Delta EEXR(2)$					
SUR(6)					
$\Delta UN(0)$					
	Δr	.00114650	4	.732348	872.220
	$\dot{W}$	.00115382	4	.730638	866.686
	$\dot{P}$	.00118005	3	.722140	847.422
	$\Delta BOPCB$	.00119313	0	.711602	838.132
	ΔTB	.00119427	0	.711326	837.332

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

See Table 3 for definition of the variables.

All equations have the functional form given at the top of this table.

Table 9. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\hat{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k} \hat{IR}_{t-k} + \sum_{k=0}^{2} a_{2k} \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k} SUR_{t-k} +$$

$$a_4 \Delta UN_t + \sum_{k=0}^{4} a_{5k} \Delta r_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\hat{IR}$(1)					
ΔEEXR(2)					
SUR(6)					
ΔUN(0)					
Δr(4)					
	$\hat{W}$	.00106985	4	.760478	934.710
	ΔBOPCB	.00109331	4	.755226	914.654
	ΔTB	.00114154	4	.744427	876.010
	$\hat{P}$	.00116460	3	.737109	858.664

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

See Table 3 for definition of the variables.

All equations have the functional form given at the top of this table.

Table 10. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\, \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k}\, \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k}\, SUR_{t-k} +$$

$$a_4\, \Delta UN_t + \sum_{k=0}^{4} a_{5k}\, \Delta r_{t-k} + \sum_{k=0}^{4} a_{6k}\, \dot{W}_{t-k} + \sum_{n=0}^{12} \beta_n\, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(1)$					
$\Delta EEXR(2)$					
$SUR(6)$					
$\Delta UN(0)$					
$\Delta r(4)$					
$\dot{W}(4)$					
	$\Delta BOPCB$	.00102255	4	.780080	977.947
	ΔTB	.00106268	5	.773236	941.017
	$\dot{P}$	.00108449	1	.761115	922.092

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

See Table 3 for definition of the variables.

All equations have the functional form given at the top of this table.

Table 11. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: United Kingdom.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k}\, \dot{IR}_{t-k} + \sum_{k=0}^{2} a_{2k}\, \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k}\, SUR_{t-k} +$$

$$a_4\, \Delta UN_t + \sum_{k=0}^{4} a_{5k}\, \Delta r_{t-k} + \sum_{k=0}^{4} a_{6k}\, \dot{W}_{t-k} + \sum_{k=0}^{4} a_{7k}\, \Delta BOPCB_{t-k} +$$

$$\sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(1)$					
$\Delta EEXR(2)$					
$SUR(6)$					
$\Delta UN(0)$					
$\Delta r(4)$					
$\dot{W}(4)$					
$\Delta BOPCB(4)$					
	$\dot{P}$	.00103327	0	.779511	968.335

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

See Table 3 for definition of the variables.

All equations have the functional form given at the top of this table.

Table 12. Estimation Results Using U.K. Data - Money Supply Reaction Functions: 1960:2 - 1983:4

$$\mathring{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{k=0}^{1} a_{1k} \mathring{IR}_{t-k} + \sum_{k=0}^{2} a_{2k} \Delta EEXR_{t-k} + \sum_{k=0}^{6} a_{3k} SUR_{t-k} + a_4 \Delta UN_t + \sum_{k=0}^{4} a_{5k} \Delta r_{t-k} + \sum_{k=0}^{4} a_{6k} \mathring{W}_{t-k} + \sum_{k=0}^{4} a_{7k} \Delta BOPCB_{t-k} + a_8 \mathring{P}t.$$

Eq. No.	C	α_1	α_2	α_3	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	$\bar{R}^2$	D-W	ρ
(12.1)	.0072	-.0235	-.0369	.0603	-.0336	.0009*	-.4068	-.0390*	-.0008	.2363	.00001	.2963	.746	2.04	-.199
	(.32)	(-.56)	(-1.50)	(1.50)	(-.98)	(2.25)	(-.71)	(-2.91)	(-.13)	(.79)	(.52)	(1.03)			(-1.97)
(12.2)	.0054	-.0215	-.0305	.0611	-.0202	.0009*	-.5990	-.0357*	.0005	.3877	.00001		.748	2.03	-.189
	(.24)	(-.51)	(-1.27)	(1.53)	(-.62)	(2.20)	(-1.10)	(-2.73)	(.08)	(1.48)	(.29)				(-1.87)
(12.3)	.0025	-.0140	-.0312	.0632	-.0275	.0015	-.3729	-.0239	.0017	.1445	-.00001	.3176	.750	2.05	-.208
	(.07)	(-.21)	(-.80)	(.89)	(-.32)	(1.24)	(-.46)	(-.66)	(.15)	(.27)	(-.18)	(.63)			(-2.06)
(12.4)	.0163	-.0095	-.0667*	.0555	-.0274	.0018**	-.9290	-.0108	.0145				.624	2.03	-.249
	(.34)	(-.09)	(-2.91)	(.58)	(-.37)	(1.60)	(-.59)	(-.56)	(1.06)						-2.49

Notes:

Figures in parentheses are t-statistics of the coefficients.
An * indicates significance at the 5% level and a** indicates significance at the 10% level.

$\bar{R}^2 = R^2$ adjusted for degrees of freedom.
See Table 3 for definition of variables.

(12.1) and (12.2) are estimated with the OLS combined with Cochrane-Orcutt first-order serial-correlation correction, while (12.3) and (12.4) are estimated with the IV procedure combined with Cochrane-Orcutt first order serial correlation correction procedure.

Table 13. Money Supply Reaction Function: United Kingdom

Estimation Period: 1960:2 - 1983:4.

Method of Estimation: Instrument Variable with Serial Correlation Correction

Dependent Variable: $\mathring{MB}_t = [\text{Log}\ (MB_t/MB_{t-1})]$.

Explanatory Variable	Estimated Coefficient	T-Statistic
C	.016301	.3379
D_1	-.009489	-.0895
D_2	-.066735	-2.9179
D_3	.055541	.5785
$\mathring{IR}$		
t	-.117106	-.9859
t-1	.089708	1.2689
ΔEEXR		
t	.000519	.4010
t-1	.000611	1.0611
t-2	.000663	1.6034
SUR		
t	-.154920	-.1279
t-1	-.085171	-.7266
t-2	-.992241	-.9013
t-3	1.224036	.8997
t-4	-.773643	-.4095
t-5	1.627462	1.2479
t-6	-1.774608	-2.4380

Table 13 (continued).

Explanatory Variable	Estimated Coefficient	T-Statistic
ΔUN_t	-.010835	-.5579
Δr		
t	.010452	.6226
t-1	-.003460	-.3537
t-2	.004974	.7156
t-3	-.004704	-1.0698
t-4	.007269	1.9907

Standard Error of Regression = .0364546

D-W Statistic = 2.03

Final Value of rho = .2497

T-Statistics for rho = 2.499

See Table 3 for definition of the variables.

II. West Germany

Estimation of the reaction function for West Germany essentially followed the same procedure as used for the United Kindgom. The estimation results for West Germany are reported in Tables 15-24. Variables used in these Tables are defined in Table 14. All the equations are estimated for quarterly data over the identical sample period (1960:2 - 1983:4) used for the United Kindgom. A suitable lag length is searched over the maximum time period of twelve quarters.

Tables 15-22 develop the basic form of the linear reaction function and determine the order in which relevant explanatory variables are added to the money supply reaction function along with the appropriate lag length of each explanatory variable. A constant term and three seasonal dummies have been added to each equation. From this step-wise procedure the basic model of the following form emerged:[8]

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k} \Delta TB_{t-k} +$$

$$a_5 DEBT_t + a_6 \dot{W}_t + a_7 \dot{P}_t + a_8 \Delta r_t \qquad (4.4)$$

Once the lag length on each causal variable and the order in which these variables enter the equation has been determined, an OLS estimate of this equation was obtained. The D-W statistic for the estimated OLS equation was 2.49.[9] Since the D-W bounds test was inconclusive,

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[8]See Table 14 for definition of variables.

[9]The D-W test statistic (d^*) is 2.49. For 95 observations and 19 independent variables (including the constant term), lower and upper bounds on this statistic are 1.247 (d_L) and 2.126 (d_u) respectively at the 5 percent level. D-W bounds test for the presence of the first-order serial correlation is inconclusive since $d_L<4-d<d_u$. See A. Koutsoyiannis (1977), p. 214.

the Q-statistic was computed to test for autocorrelation in the residuals. The Q test indicated the presence of autocorrelation in the residuals. The estimated value of the Q statistics (for the first-order serial correlation) for this equation was 6.78. The null hypothesis of no first-order serial correlation was rejected at the 5% level since the calculated value of the Q statistic is higher than the critical value of $X^2_{(1)}$ at the 5% level (.0039). Since the OLS results are inefficient in the presence of a serially correlated error term, the Cochrane-Orcutt (C-O) iterative procedure for the correction for first-order autocorrelation was combined with OLS.

The estimated reaction function of the monetary authority in West Germany is presented in Table 23. Equation (23.1) reports the OLS estimates, corrected for first-order serial correlation, for the model specified in equation (4.4). In this equation significant coefficients on the international reserves variable (a_1) and the government debt variable (a_5) are reported. The estimated coefficient on the price variable (a_7) is significant only at the 20% level of significance. Even though the sums of coefficients on the unemployment rate variable (a_2), the effective exchange rate variable (a_3), and the trade balance variable (a_4) are insignificant, statistically significant individual coefficients on these variables were reported. Since variations in the wage rate variable (a_6) and the short-term interest rate variable (a_8) do not contribute to the behavior of the monetary authority, the reaction function is reestimated after dropping these variables. Results are reported in equation (23.2).

Both equations (23.1) and (23.2) are estimated using the OLS and C-O procedures. Both equations exhibit similar signs on all coefficients; the coefficient on the government debt variable (a_5) remains significant at the 10% level and the coefficient on the international reserves variable (a_1) remains significant at the five percent level. Thus, a similar pattern of results is observed in both equations.[10] These results suggest that the monetary authority in West Germany responded to the changes in the international trade variable and the government debt variable. An improvement in the reserve position led to monetary expansion. For every percentage point increase in $I\dot{R}$, the growth rate of the monetary base ($M\dot{B}$) increased by .14% in the same period. The evidence also suggests that the monetary authorities have no inclination to accomodate a fiscal deficit, since the coefficient on the governmental debt variable is statistically significant with a negative sign indicating that expansionary fiscal policies are countered by restrictive monetary policies.

To take into account the possible endogeneity among contemporaneous values of the causal and caused variables, equation (23.1) and (23.2) are reestimated using the instrumental variable technique (with first order serial correlation correction). A time trend, a detrended government expenditure (current and three lagged values) variable, one additional lag on each explanatory variable, and the lagged dependent variable were used as instrumental variables. Lagged dependent variable ($M\dot{B}_{t-1}$) is used as an instrumental variable, since Fair's technique for choosing the set of instrumental variables is followed.

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[10]The Q-statistics for the first-order serial correlation for equations (23.1) and (23.2), are .000085 and .000072. Since the estimated value of the Q statistics are lower than the tabulated value of $\chi^2_{(1)}$ (.0039), the null hypothesis of no further first-order serial correlation (i.e., Ho: $\rho_1 = \rho_2 = \dots = \rho_k = 0$) is not rejected.

According to Fair (1970), the lagged dependent and independent variables should be included as separate instruments to ensure consistent instrumental variable estimates in models with a first-order serial correlation correction. The sums of the coefficients on different explanatory variables and the significance of their sums (in terms of t-statistics) are reported in equations (23.3) and (23.4) in Table 23. The change in the nature of the results that takes place with the use of the instrumental variable (IV) technique points to simultaneity problems. Comparing equations (23.1) and (23.3) (both equations estimate the same model with OLS and IV respectively), we observe a sign reversal on coefficients on the fiscal policy variable (a_5), the wage rate variable (a_6), and the short term interest rate variable (a_8) with the use of the IV procedure. The coefficients on the international reserves variable (a_1) and the government debt variable are no longer significant. The insignificant t-statistic on all other economic variables suggests that none of these variables has a lasting impact on the behavior of the monetary authority.

A restricted model was estimated after dropping the last four explanatory variables from the reaction function (i.e., the government debt variable, the wage rate variable, the price variable and the short-term interest rate variables). These variables are dropped because of the reported insignificant coefficients in equation (23.3). However, it should be noted that the trade balance variable and other variables with insignificant t-statistics for the sums of their coefficients are not dropped because individual significant coefficients were observed on these variables. The international reserves variable was retained in spite of an insignificant coefficient (a_1)

because this variable is highly significant in equations (23.1) and (23.2).

A comparison of equations (23.2) and (23.4) also reveals some significant changes from the OLS results (23.2) when the model is reestimated with IV (23.4). Even though the signs on all economic variables remain the same, some coefficients change in magnitude (e.g., the coefficient on the international reserves variable, a_1, increases from .14 to .16). The coefficient on the international reserve variable is significant at the 10% level. A 1% point increase in international reserves (e.g., from .01 to .02) led to an increase in $\hat{MB}$ of .16% in the same period.

Instrumental Variable results (23.4) seem to suggest that other economic variables under consideration do not have a lasting effect on the behavior of the monetary authority in West Germany. However, it is possible that some temporary adjustments in the monetary base take place in response to changes in these variables. To analyze the interim changes in the behavior of the monetary authority, detailed results of equation (23.4) are required. The detailed estimation results for equation (23.4) are contained in Table 24.

Even though the sums of the coefficients on the unemployment variable, the effective exchange rate variable and the trade balance variable are insignificant, these factors have contributed to monetary policy as is evident from the individual lagged coefficients on these variables (Table 24). Some delayed response of the monetary authority to changes in the unemployment rate is suggested. An increase of one percentage point in the unemployment rate in period 0 led to a .02% decrease in $\hat{MB}$ in the third quarter (t + 2). The monetary authority reduced the supply of money in accordance with the reduction in the demand for money caused by a decline in the level of the economic activity. Thus, monetary authorities appear to have responded temporarily in a procyclical fashion to the change in the unemployment rate. However, this variable exercised no permanent influence on monetary policy.

A one percent increase in the effective exchange rate led to a .0009% decrease in the $M\dot{B}$ in the next quarter (t+1). Table 24 suggests that an increase in the trade balance of one million DM in period t led to a .02% decrease in $M\dot{B}$ in the third quarter (t+2) and a .01% increase in $M\dot{B}$ in the fourth quarter (t+3). But, variations in trade balance did not have any lasting impact on the monetary base.

The result of this study are somewhat disappointing and are not consistent with those of previous studies. A priori it might be expected that the German monetary authority has given special attention to the price stability goal because of Germany's previous experience with hyperinflation. Our findings, however, suggest that the inflation rate was not a determinant of the monetary base for the period under review. This result does not compare well with previous studies. Willms (1983) established the price stability goal as the major determinant of monetary policy in West Germany over the period 1960-1982. Hodgman and Resek (1983) also found evidence that monetary policy reacted systematically to movements in the price variable.

Hodgman and Resek (1983) established evidence relating monetary policy to the external stability objective (some evidence of external stability objective is established in the present study), cyclical factors (rate of capacity utilization) and price inflation. As in our

Table 14. Definition of Variables: West Germany

$\dot{MB}_t$ = Quarterly rate of change of the monetary base, period t

$\dot{IR}_t$ = Quarterly rate of change of international reserves, period t.

ΔIR_t = Quarterly changes in international reserves, period t.

$\Delta EEXR_t$ = Quarterly changes in the index of effective exchange rate, period t.

ΔEXR_t = Quarterly changes in the index of bilateral exchange rate between Deutsche Mark and dollar, period t.

ΔUN_t = Quarterly changes in the unemployment rate, period t.

OG_t = Output gap, period t.

OR_t = Output ratio, period t.

$\dot{P}_t$ = Quarterly rate of change in prices, period t.

$\Delta BOPCB_t$ = Quarterly changes in balance of payments, current balance, period t.

ΔTB_t = Quarterly changes in trade balance, period t.

SUR_t = Detrended budget surplus

$$\left(\frac{\text{Nominal budget surplus}}{\text{Trend real GNP} \times \frac{\text{IPD}}{100}}\right), \text{ period t.}$$

$DEBT_t$ = Detrended change in Government debt

$$\left(\frac{\Delta \text{ Nominal Government debt}}{\text{Trend real GNP} \times \frac{\text{IPD}}{100}}\right), \text{ period t.}$$

Δr_t = Quarterly changes in short-term interest rate (call-money rate), period t.

$\dot{W}_t$ = Quarterly rate of change in wages, period t.

Table 15. Determination of Lag Length and Specific Gravity of Manipulated Variables in Bivariate Equations: West Germany.

$$M\hat{B}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{n=0}^{12} \beta_n X_{t-n}$$

Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$I\hat{R}$	.00159767	0	.514753	625.90
ΔIR	.00176233	0	.464744	568.18
ΔTB	.00177793	3	.475732	562.46
ΔBOPCB	.00195700	1	.411502	510.99
OR	.00187657	6	.462309	532.88
OG	.00191115	7	.457518	523.26
ΔUN	.00182958	3	.460503	546.57
ΔEEXR	.00184960	1	.443801	540.66
ΔEXR	.00205780	0	.375004	485.44
$\hat{W}$	.00205057	0	.377197	487.66
Δr	.00205397	0	.376166	486.85
$\hat{P}$	.00206092	0	.374054	485.20
SUR	.00206183	0	.373780	485.01
DEBT	.00255521	0	.375790	391.39

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 16. Determination of Lag Length and Specific Gravity of Manipulated Variables in Trivariate Equations: West Germany.

$$\dot{MB}_t = C + \Sigma\, \alpha_i D_i + a_1\, \dot{IR}_t + \sum_{n=0}^{12} \beta_n\, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specifc Gravity
$\dot{IR}(0)$					
	ΔUN	.00147176	3	.570188	679.49
	OR	.00154179	6	.562362	648.59
	OG	.00157861	7	.556057	633.47
	ΔTB	.00152807	3	.553744	654.45
	ΔBOPCB	.00154540	1	.539833	647.08
	ΔEEXR	.00153426	1	.543149	651.80
	ΔEXR	.00162992	0	.509859	613.53
	$\dot{W}$	.00162779	0	.510500	614.33
	Δr	.00162983	0	.509888	613.57
	$\dot{P}$	.00163167	0	.509334	612.86
	SUR	.00163173	0	.509317	612.86
	DEBT	.00162508	0	.511316	615.35

[a]The number in parentheses beside the controlled variable is the optimal order of the lag (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 17. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}$(0)					
ΔUN(3)					
	ΔEEXR	.00138404	1	.603431	722.54
	ΔEXR	.00150300	0	.565243	665.34
	ΔTB	.00140969	3	.603563	709.37
	ΔBOPCB	.00147773	7	.599270	676.73
	$\dot{P}$	.00149828	0	.566609	667.56
	$\dot{W}$	.00150042	0	.565990	666.49
	Δr	.00150078	0	.565886	666.22
	SUR	.00150338	0	.565135	665.16
	DEBT	.00149898	0	.566408	667.16

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 18. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(0)$					
$\Delta UN(3)$					
$\Delta EEXR(1)$					
	ΔTB	.00129920	3	.641277	769.70
	$\Delta BOPCB$	.00137620	1	.598856	726.64
	$\dot{P}$	.00140595	0	.600918	711.23
	$\dot{W}$	.00140632	0	.600814	711.08
	Δr	.00141256	0	.599041	707.97
	SUR	.00141392	0	.598657	707.26
	DEBT	.00140218	0	.597136	713.16

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 19. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k} \Delta TB_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(0)$					
$\Delta UN(3)$					
$\Delta EEXR(1)$					
$\Delta TB(3)$					
	DEBT	.00129827	0	.644764	770.24
	SUR	.00132736	0	.636803	753.35
	$\dot{P}$	.00132126	0	.638473	756.89
	$\dot{W}$	.00132577	0	.637240	754.26
	Δr	.00132618	0	.637128	754.03

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 20. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k}$$

$$\Delta TB_{t-k} + a_5 \, DEBT_t + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(0)$					
$\Delta UN(3)$					
$\Delta EEXR(1)$					
$\Delta TB(3)$					
DEBT(0)					
	$\dot{W}$	.00131676	0	.642921	759.44
	$\dot{P}$	.00131813	0	.642549	758.65
	Δr	.00132461	0	.640792	754.94

[a]The numbers in parentheses besides the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 21. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k}$$

$$\Delta TB_{t-k} + a_5 DEBT_t + a_6 \dot{W}_t + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(0)$					
$\Delta UN(3)$					
$\Delta EEXR(1)$					
$\Delta TB(3)$					
DEBT(0)					
$\dot{W}(0)$					
	$\dot{P}$	.00133487	0	.641214	749.14
	Δr	.00134375	0	.638826	744.19

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 22. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: West Germany.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k}$$

$$\Delta TB_{t-k} + a_5 \, DEBT_t + a_6 \dot{W}_t + a_7 \dot{P}_t + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
$\dot{IR}(0)$					
$\Delta UN(3)$					
$\Delta EEXR(1)$					
$\Delta TB(3)$					
DEBT(0)					
$\dot{W}(0)$					
$\dot{P}(0)$					
	Δr	.00136368	0	.636684	733.31

[a]The numbersin parentheses besides the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 14.

All equations have the functional form given at the top of this Table.

Table 23. Estimation Results Using German Data - Money Supply Reaction Function: 1960:2 -1983:4

$$\hat{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \hat{IR}_t + \sum_{k=0}^{3} a_{2k} \Delta UN_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta EEXR_{t-k} + \sum_{k=0}^{3} a_{4k} \Delta TB_{t-k} + a_5 DEBT_t + a_6 \dot{W}_t + a_7 \dot{P}_t + a_8 \Delta r_t.$$

Eq. No.	C	α_1	α_2	α_3	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	$\bar{R}^2$	D-W	ρ
(23.1)	.0424*	-.0624*	-.0051	-.0351**	.1385*	-.0224	.0001	.0079	-2.2475**	-.1748	.8788	.0006	.58	2.00	-.300
	(3.18)	(-3.25)	(-.28)	(-1.86)	(3.28)	(-1.27)	(.20)	(.62)	(-1.82)	(-.73)	(1.42)	(.14)			(-3.05)
(23.2)	.0396*	-.0631*	-.0071	-.0353**	.1388*	-.0229	.0001	.0082	- 1.9108**		.8124		.59	2.00	-.3016
	(3.13)	(-3.33)	(-.39)	(-1.89)	(3.59)	(-1.43)	(.24)	(.67)	(-1.69)		(1.38)				(-3.07)
(23.3)	.0261	-.0769*	.0023	-.0226	.0724	-.0650	.0015	.0015	.3785	.2104	1.1379	-.0164	.54	1.90	-.271
	(1.30)	(-3.06)	(.08)	(-.84)	(.52)	(-1.08)	(.55)	(.06)	(.14)	(.26)	(.76)	(-.73)			(-2.73)
(23.4)	.0354*	-.0668*	.0125	-.0296	.1637**	-.0229	.00008	.0140					.64	1.96	-.255
	(2.87)	(-3.30)	(.51)	(-1.53)	(1.64)	(-1.32)	(.07)	(.90)							(-2.55)

Notes:

Figures in parentheses are t-statistics of the sum of the coefficients.

$\bar{R}^2 = R^2$ adjusted for degrees of freedom.

Variables are defined in Table 14.

An * indicates significance at the 5% level and a ** indicates significance at the 10% level.

(23.1) and (23.2) have been estimated with OLS while (24.3) and (24.4) have been estimated with IV procedure. These estimation procedures are used in conjunction with the Cochrane-Orcutt iterative procedure to adjust for first-order serial correlation in residuals.

Table 24. Money Supply Reaction Function: West Germany.
Estimation Period: 1960:2 - 1983:4.
Method of Estimation = Instrumental Variable with Serial Correlation Correction

Dependent Variable: $\mathring{MB}_t$ = Log (MB_t/MB_{t-1}).

Explanatory Variable	Estimated Coefficient	T-statistic
C	.035413	2.8664
D_1	-.066801	-3.2998
D_2	.012506	.5086
D_3	-.029648	-1.5274
$\mathring{IR}$		
t	.163709	1.6453
ΔUN		
t	-.005793	-.3053
t-1	-.004715	-.4009
t-2	-.024657	-2.4755
t-3	.012242	1.2216
ΔEEXR		
t	.000949	.5863
t-1	-.000868	-1.4026
ΔTB		
t	.019875	1.0088
t-1	-.001386	-.1314
t-2	-.019564	-1.8759
t-3	.015087	1.4278

Standard Error of the Regression = .033544

D-W Statistic = 1.9548

No. of observations = 94

Final value of rho = -.2546

t-statistic for rho = -2.5532

Variables are defined in Table 14.

study, the government budget deficit had no significant influence on German monetary policy. Gordon (1977), however, found evidence of both a positive budget deficit-money supply linkage and a positive wage-money supply linkage that have not been substantiated by any other study. Countercyclical policy reactions were also noted by him, leading him to say that German authorities are "...inconsistent, resisting higher prices of traded goods but allowing the growth rate of the money supply to rise in response to higher wage rates" (Gordon, 1977, p. 434).

In summation, the estimated reaction functions in this study establish the international reserves variables as a systematic determinant of the monetary policy. Some temporary adjustments in monetary base are also observed. The Bundesbank has adjusted the monetary base in a procyclical manner. Short-term adjustments in the monetary policy do take place in response to changes in the foreign trade variables.

III. Canada

The final country in our sample is Canada. Tables 26-33 develop the basic form of the monetary policy reaction function. Variables used in Tables 26-36 are defined in Table 25. Relevant explanatory variables in the estimated reaction function are chosen, on the basis of the specific gravity criterion, from the set of plausible explanatory variables. The appropriate lag length for every explanatory variable is searched over twelve quarters. The chosen lag length is the one minimizing the Final Prediction Error [FPE]. The money supply reaction function of the following form was shaped by the step-wise procedure followed in Tables 26-33.

$$M\hat{B}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \, OG_t + \sum_{k=0}^{3} a_{2k} \, SUR_{t-k} + \sum_{k=0}^{4} a_{3k} \, \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k} \, \hat{P}_{t-k} + a_5 \, \Delta EEXR_t + a_6 \, I\hat{R}_t + a_7 \, \Delta BOPNT_t + a_8 \, \hat{W}_t. \tag{4.5}$$

The estimated reaction functions of the monetary authority in Canada are reported in Table 34. Table 34 contains the sum of the coefficients on each independent variable and the significance of this sum (in terms of t-statistics). Equation (34.1) contains the OLS estimates of the model presented in equation (4.5). Since the D-W statistic and the Q test indicated the absence of serial correlation, only OLS estimates are reported. Once this equation was estimated, separate F-tests were performed to test the joint significance of coefficients on individual explanatory variables. Results of the F-tests are contained in Table 36.

The F-tests substantiate the hypothesis that variations in the index of the effective exchange rate, international reserves, balance of payments and wage rate are not associated with any variations in the monetary base in Canada for the sample period under study. The output gap, the budget surplus, the short-term interest rate, and the inflation rate are the relevant variables in explaining the behavior of the monetary authority in Canada. The reaction function is re-estimated, using OLS, after dropping the last four variables from equation (34.1). Equation (34.2) reports these estimates.

Equations (34.1) and (34.2) both yield the same statistical fit for the reaction function (in terms of $\bar{R}^2$) and yield similar estimates for the sum of coefficients on different explanatory variables. The sums of coefficients on the short-term interest rate variable (a_3) and the output gap variable (a_1) remain significant at the 5% level. The sum of the coefficients on the budget surplus variable (a_2) is now significant at the 5% level (instead of the 10% level). Significant coefficients on the seasonal dummy variables suggest a seasonal pattern in the behavior of the monetary authority. The estimated reaction function (34.2) establishes the interest rate variable, the economic activity variable (i.e., the output gap variable), and the fiscal policy variable as the systematic determinants of the monetary policy in Canada for the sample period under consideration.

Equations (34.1) and (34.2) are re-estimated using the instrumental variable (IV) technique to take into account any possible simultaniety problems. Results are contained in equations (34.3) and (34.4). Equation (34.3) reports the estimated parameters of the model specified in equation (4.5). Since F-tests (Table 36) indicate that the coefficients on the effective exchange rate variable, international reserves variable, balance of payments variable and the wage rate variable do not explain the variations in the monetary base, the reaction function is re-estimated after dropping these variables and using IV technique. The estimated reaction function is reported in equation (34.4). An inspection of the four equations in Table 34 reveals that both the estimation procedures (OLS and IV) yield the same statistical fit ($\bar{R}^2$) for the reaction functions and similar signs for the sums of coefficients on different explanatory variables. A comparison of equations (34.1) and (34.3) reveals some changes in the magnitude of the sums of coefficients on different explanatory variables and the associated t-statistics. The t-statistics for the budget surplus variable (a_2), the short-term interest rate variable (a_3) and the effective exchange rate variable (a_5) decline significantly. The t-statistic for the sum of coefficients on the budget surplus variable registers a decline from 1.91 to 1.16 with the use of the IV technique, while the t-statistic for the sum of coefficients on the short-term interest rate variable changes from -2.53 to -1.40. Coefficients on the budget surplus variable and the short-term interest rate variable are no longer significant. The D-W statistic for equation (34.3) is in the inconclusive range.

A comparison of equations (34.2) and (34.4) exhibits no major changes from the OLS results when the instrumental variable technique is used. Both these equations establish the output gap variable, the fiscal policy variable and the short-term interest rate variable as systematic determinants of monetary policy (even though, the last two variables are significant only at the 10% level when the IV technique is used). The output gap variable has a positive sign and is significant at the 5% level of confidence. The positive sign on the output gap variable indicates a procyclical response of the monetary authority. The central bank responded to the increase in demand for money that accompanies an upswing in the level of economic activity by expanding the monetary base. An increase in the output gap of 1% point (i.e., from .01 to .02) led to an increase in MB of .0026 percent in the same period. While the response of the monetary authority to a change in the level of economic activity took place within the same time period, considerable lags in monetary policy existed with respect to the other explanatory variables.

Equation (34.4) reveals a positive budget surplus-money supply linkage. _A priori_, a positive coefficient was not expected. One plausible interpretation of this positive coefficient is as follows. Assuming that the budget surplus is an acceptable proxy for the stance of fiscal policy, an increase in the surplus should reduce aggregate demand. The Canadian central bank apparently responds by increasing monetary base growth. It seems to respond more to the macro consequences of the change in the surplus than to the money market consequences. A similar pattern of the reaction of the monetary authority is observed from the coefficient on the short-term interest rate variable. The short-term interest rate is related negatively to the growth rate of the monetary base and is significant at the 5% level of confidence. These results suggest that a rise in the interest rate leads the central bank to reduce $\dot{MB}$.

An analysis of the individual lagged coefficients on different explanatory variables is needed in order to ascertain the temporary adjustments in the behavior of the monetary authority. The detailed estimation results for equation (34.4) are presented in Table 35.

An analysis of the individual lagged coefficients on the budget surplus variable reveals the oscillatory reaction pattern of the monetary authority. An increase in the budget surplus (as a ratio of real trend GNP) of 1% led to a contraction in the growth rate of monetary base of 1.55% in the third quarter (t+2), and a 2.14% increase in $\dot{MB}$ in the fourth quarter (t+3). Thus, over the four-quarter periods, the central bank of Canada reacted to a 1% increase in the budget surplus (as a ratio of real trend GNP) with a .723% increase in $M\dot{B}$. It seems that the monetary authority tried to take into account both the macro consequences (i.e., price fluctuations) and the money market consequences (i.e., interest rate fluctuations) of the increase in the budget surplus, but its responsiveness to the macro implications of a budget surplus was greater than its concern for the money market fluctuations.

A one unit increase in the short-term interest rate today leads to a .003% decrease in $M\dot{B}$ in t+1 and a .007% decrease in $M\dot{B}$ in t+4. Thus, if r rises by 1% in period 0, and remains at the new level for the next four quarters, then at the end of the fifth quarter (t+4), $M\dot{B}$ will be .0087% lower than before the sustained 1% increase in r took place. It seems that the central bank in Canada acted so as to reinforce rather than to reduce the fluctuations in the short-term interest rate.

The sum of coefficients on the price variable has the expected negative sign but is statistically insignificant.

Our evidence suggests that the monetary authorities in Canada reacted systematically to variations in the output gap, budget surplus, and short-term interest rate for the sample period under consideration. However, none of these variables had the anticipated sign. Monetary expansion also followed a seasonal pattern, as is evident from the signficance of seasonal dummy variables.

Table 25. Definition of Variables: Canada

$\hat{MB}_t$ = Quarterly rate of change of the monetary base, period t.

$\hat{IR}_t$ = Quarterly rate of change of international reserves, period t.

ΔIR_t = Quarterly changes in international reserves, periot t.

ΔUN_t = Quarterly changes in the unemployment rate, period t.

OG_t = Output Gap, period t.

OR_t = Output ratio, period t

ΔEXR_t = Quarterly changes in the index of bilateral exchange rate between Canadian dollar and American dollar, period t.

$\Delta EEXR_t$ = Quarterly changes in the index of effective exchange rate, period t.

$\hat{P}_t$ = Quarterly rate of change in prices, period t.

Δr_t = Quarterly changes in short-term interest rate (treasury-bill rate) period t.

SUR_t = Detrended budget surplus

$$\left[\frac{\text{Nominal budget surplus}_t}{\text{Trend real GNP} \times \frac{IPD}{100}}\right], \text{ period t.}$$

$DEBT_t$ = Detrended change in Government Debt

$$\left[\frac{\Delta \text{ Nominal Government Debt}}{\text{Trend real GNP} \times \frac{IPD}{100}}\right], \text{ period t.}$$

$\hat{W}_t$ = Quarterly rate of change in wages, period t.

$\Delta BOPNT_t$ = Quarterly changes in balance of payments, net trade, period t.

$\Delta BOPCB_t$ = Quarterly changes in balance of payments, current balance, period t.

Table 26. Determination of Lag Length and Specific Gravity of Manipulated Variables in Bivariate Equations: Canada

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Variable (X)	Minimum FPE	Lag Length	$\bar{R}^2$	Specific Gravity
OG	.00028739	0	.832662	3479.47
OR	.00029353	0	.832106	3407.15
ΔUN	.00032922	0	.808307	3037.67
SUR	.00029201	5	.838071	3424.66
DEBT	.00033836	0	.802985	2955.08
ΔEEXR	.00032247	0	.812237	3100.77
ΔEXR	.00033533	0	.804747	2982.40
$\dot{P}$	.00032109	0	.813041	3114.29
Δr	.00033041	7	.820199	3026.63
$\dot{W}$	.00031335	1	.806903	3191.83
ΔBOPNT	.00033181	8	.821113	3013.86
ΔBOPCB	.00033512	4	.810553	2984.18
ΔIR	.00033516	0	.804851	2983.29
$\dot{IR}$	.00033653	0	.804051	2971.77

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 27. Determination of Lag Length and Specific Gravity of Manipulated Variables in Trivariate Equations: Canada

$$M\hat{B}_t = C + \Sigma\, \alpha_i D_i + a_1\, OG_t + \sum_{n=0}^{12} \beta_n X_{t-n}$$

Controlled Variable	Manipulated Variables (X)	Minimum FPE	Lag Length	$\bar{R}^2$	Specific Gravity
OG(0)					
	SUR	.00023834	3	.866561	4196.39
	DEBT	.00029019	5	.840596	3445.90
	ΔEEXR	.00027688	0	.840382	3611.41
	ΔEXR	.00028878	0	.833518	3463.80
	$I\hat{R}$	.00028032	10	.852952	3567.61
	ΔIR	.00028427	10	.850881	3517.41
	ΔBOPNT	.00028634	10	.849795	3492.84
	ΔBOPCB	.00029109	4	.838582	3435.25
	Δr	.00024380	8	.869768	4101.72
	$\hat{W}$	.00028700	2	.837759	3484.32
	$\hat{P}$	.00029132	1	.833699	3432.89

[a]The number in parentheses beside the controlled variable is the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 28. Determination of Lag Length and Specific Gravity of the Manipulated Variables in Multivariate Equations: Canada

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1\ OG_t + \sum_{k=0}^{3} a_{2k}\ SUR_{t-k} + \sum_{n=0}^{12} \beta_n\ X_{t-n}.$$

Controlled Variable[a]	Manipulated Variables (X)	Minimum FPE	Lag Length	R^2	Specific Gravity
OG(0)					
SUR(3)					
	Δr	.00021652	4	.884338	4618.94
	$\dot{P}$	.00023377	2	.872887	4277.16
	$\dot{W}$	.00024318	0	.865148	4111.84
	ΔEEXR	.00022974	0	.872602	4353.50
	ΔEXR	.00024268	0	.865424	4120.31
	ΔBOPNT	.00023621	1	.870247	4233.70
	ΔBOPCB	.00023912	4	.872267	4182.35
	$\dot{IR}$	.00024233	4	.870549	4127.11
	ΔIR	.00024246	4	.870479	4123.71

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 29. Determination of Lag Length and Specific Gravity of the Manipulated Variables in Multivariate Equations: Canada

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \dot{OG}_t + \sum_{k=0}^{3} a_{2k} SUR_{t-k} + \sum_{k=0}^{1} a_{3k} \Delta r_{t-k} + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	R^2	Specific Gravity
OG(0)					
SUR(3)					
Δr(4)					
	$\dot{P}$	.00021272	2	.889414	4701.46
	ΔEEXR	.00021282	0	.887349	4699.25
	ΔEXR	.00021905	0	.884048	4566.21
	$I\dot{R}$	.00021886	0	.884150	4568.29
	ΔIR	.00022076	0	.883145	4528.98
	$\dot{W}$	.00022107	0	.882981	4522.84
	ΔBOPCB	.00022112	0	.882956	4522.84
	ΔBOPNT	.00022117	0	.882930	4522.84

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 30. Determination of Lag Length and Specific Gravity of Manipulated Variables in Multivariate Equations: Canada

$$M\dot{B}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \, OG_t + \sum_{k=0}^{3} a_{2k} \, SUR_{t-k} + \sum_{k=0}^{4} a_{3k} \, \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k} \, \dot{P}_{t-k} + \sum_{n=0}^{12} \beta_n \, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
OG(0)					
SUR(3)					
Δr(4)					
$\dot{P}$(2)					
	ΔEEXR	.00020893	0	.892341	4784.69
	ΔEXR	.00021154	0	.890998	4716.98
	$\dot{IR}$	.00021230	0	.890608	4716.98
	ΔIR	.00021498	0	.889225	4651.16
	$\dot{W}$	.00021684	0	.888268	4578.75
	ΔBOPCB	.00021730	0	.888031	4601.93
	ΔBOPNT	.00021734	0	.888012	4601.93

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 31. Determination of Lag Length and Specific Gravity of the Manipulated Variables in Multivariate Equations: Canada

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \, OG_t + \sum_{k=0}^{3} a_{2k} \, SUR_{t-k} + \sum_{k=0}^{4} a_{3k} \, \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k} \, \dot{P}_{t-k} +$$

$$a_5 \, \Delta EEXR_t + \sum_{n=0}^{12} \beta_n \, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
OG(0)					
SUR(3)					
Δr(4)					
$\dot{P}$(2)					
ΔEEXR(0)					
	$\dot{IR}$	.00021007	0	.892707	4759.64
	ΔIR	.00021231	0	.891559	4710.32
	$\dot{W}$	.00021301	0	.891203	4694.62
	ΔBOPCB	.00021327	0	.891073	4688.23
	ΔBOPNT	.00021350	0	.890952	4683.84

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 32. Determination of Lag Length and Specific Gravity of the Manipulated Variables in Multivariate Equations: Canada

$$M\dot{B}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 OG_t + \sum_{k=0}^{3} a_{2k} SUR_{t-k} + \sum_{k=0}^{4} a_{3k} \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k} \dot{P}_{t-k} +$$

$$a_5 \Delta EEXR_t + a_6 I\dot{R}_t + \sum_{n=0}^{12} \beta_n X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	$\bar{R}^2$	Specific Gravity
OG(0)					
SUR(3)					
Δr(4)					
$\dot{P}$(2)					
ΔEEXR(0)					
I$\dot{R}$(0)					
	ΔBOPNT	.00021338	0	.891962	4686.03
	ΔBOPCB	.00021404	0	.891628	4672.90
	$\hat{W}$	.00021407	0	.891615	4670.71

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 33. Determination of Lag Length and Specific Gravity of the Manipulated Variables in Multivariate Equations: Canada

$$M\hat{B}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1 \, OG_t + \sum_{k=0}^{3} a_{2k} \, SUR_{t-k} + \sum_{k=0}^{4} a_{3k} \, \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k} \, \hat{P}_{t-k} +$$

$$a_5 \, \Delta EEXR_t + a_6 \, I\hat{R}_t + a_7 \, \Delta BOPNT_t + \sum_{n=0}^{12} \beta_n \, X_{t-n}.$$

Controlled Variable[a]	Manipulated Variable (X)	Minimum FPE	Lag Length (in quarters)	R^2	Specific Gravity
OG(0)					
SUR(3)					
Δr(4)					
$\hat{P}$(2)					
ΔEEXR(0)					
I$\hat{R}$(0)					
ΔBOPNT(0)					
	$\hat{W}$	.00021814	0	.890505	4584.21

[a]The numbers in parentheses beside the controlled variables are the optimal order of the lags (in quarters).

Variables are defined in Table 25.

All equations have the functional form given at the top of this Table.

Table 34. Estimation Results Using Canadian Data - Money Supply Reaction Function: 1960:2 - 1983:4.

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1\, OG_t + \sum_{k=0}^{3} a_{2k}\, SUR_{t-k} + \sum_{k=0}^{4} a_{3k}\, \Delta r_{t-k} + \sum_{k=0}^{2} a_{4k}\, \dot{P}_{t-k} + a_5\, \Delta EEXR_t + a_6\, \dot{IR}_t + a_7\, \Delta BOPNT_t + a_8\, \dot{W}_t.$$

Eq. No.	C	α_1	α_2	α_3	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	$\bar{R}^2$	D-W
(34.1)	.0708*	-.1019*	-.0217*	-.0560*	.0025*	.7105**	-.0096*	-.1374	.0002	.0203	.0021	-.0075	.89	1.83
	(14.49)	(-20.42)	(-.4.68)	(-12.38)	(4.68)	(1.91)	(-2.53)	(-.49)	(1.53)	(1.22)	(.49)	(-.48)		
(34.2)	.0715*	-.1029*	-.0219*	-.0557*	.0024*	.7474*	-.0096*	-.1512					.89	1.91
	(15.61)	(-23.11)	(-4.78)	(-12.36)	(4.62)	(2.11)	(-2.55)	(-.61)						
(34.3)	.0723*	-.0962*	-.0176*	-.0533*	.0030*	.8596	-.0100	-.2376	.00007	.0192	.0100	-.1338	.87	1.70
	(7.36)	(-12.13)	(-2.38)	(-8.00)	(3.36)	(1.16)	(-1.40)	(-.26)	(.12)	(.44)	(1.04)	(-.16)		
(34.4)	.0719*	-.1021*	-.0201*	-.0542*	.0026*	.7233**	-.0087**	-.2516					.89	1.91
	(14.39)	(-20.92)	(-3.24)	(-9.26)	(3.63)	(1.87)	(-1.65)	(-.79)						

Notes:

Figures in parentheses are t-statistics of the coefficients.

$\bar{R}^2$ = R^2 adjusted for degrees of freedom.

Variables are defined in Table 25.

An * indicates significance at the 5% level and ** indicates significance at the 10% level.

(34.1) and (34.2) have been estimated with OLS while (34.3) and (34.4) have been estimated with IV procedure.

Table 35. Money Supply Reaction Function: Canada
Estimation Period: 1960:2 - 1983:4.

Method of Estimation: Instrumental Variable Technique

Dependent Variable: $\dot{MB}_t$ = Log $[MB_t/MB_{t-1}]$.

Explanatory Variable	Estimated Coefficient	T-Statistic
C	.071953	14.3899
D_1	-.102112	-20.9224
D_2	-.020069	-3.2399
D_3	-.054184	-9.2631
<u>OG</u>		
t	.002647	3.6321
<u>SUR</u>		
t	-.431229	-.5154
t-1	.563729	.8763
t-2	-1.552321	-2.8551
t-3	2.143167	3.9794
<u>Δr</u>		
t	-.000661	-.2209
t-1	-.003169	-1.9767
t-2	+.000460	.2260
t-3	-.000649	-.4178
t-4	-.007418	-2.9066
<u>$\dot{p}$</u>		
t	.440376	.5972

Table 35 (continued).

Explanatory Variable	Estimated Coefficient	T-Statistic
t-1	-.301592	-.6738
t-2	-.390392	-1.0037

Standard Error of the Regression = .042165

R^2 = .91

$\bar{R}^2$ = .89

D-W Statistic = 1.91

No. of Observations = 95

F-Statistic (16,78) = 47.7162

Variables are defined in Table 25.

Table 36. Multivariate F-Tests for Joint Significance of Coefficients

$$\dot{MB}_t = C + \sum_{i=1}^{3} \alpha_i D_i + a_1\ OG_t + \sum_{k=0}^{3} a_{2k}\ SUR_{t-k} + \sum_{k=0}^{4} a_{3k}\ \Delta r_{t-k} +$$

$$\sum_{k=0}^{2} a_{4k}\ \dot{P}_{t-k} + a_5\ \Delta EEXR_t + a_6\ I\dot{R}_t + a_7\ \Delta BOPNT_t\ a_8\ \dot{W}_t.$$

Hypothesis	F-Statistics
1. $a_1 = 0$	21.96 (1,74)*
2. $a_{20} = a_{21} = a_{22} = a_{23} = 0$	5.80 (4,74)*
3. $a_{30} = a_{31} = a_{32} = a_{33} = a_{34} = 0$	3.24 (5,74)**
4. $a_{40}\ a_{41} = a_{42} = 0$	2.44 (3,74)
5. $a_5 = 0$	2.35 (1,74)
6. $a_6 = 0$	1.48 (1,74)
7. $a_7 = 0$	.24 (1,74)
8. $a_8 = 0$	0.002 (1,74)

[a]An * indicates significance at the 1% level, while a ** indicates significance at the 5% level. Hypotheses 4 is rejected at the 10% level of significance.

Figures in parentheses besides the calculated F-statistic represent the degrees of freedom for the F-test for the numerator and the denominator respectively.

Variables are defined in Table 25.

CHAPTER V

SUMMARY AND CONCLUSIONS

The primary objective of this study was to estimate the money-supply reaction function for the United Kingdom, West Germany and Canada. The general model developed in Chapter III showed the quarterly rate of change in the monetary base as being determined by a linear function of economic variables. No a priori restriction was imposed on the model in terms of a predetermined lag structure. The minimum final prediction error criterion in conjunction with the specific gravity criterion was used to determine the optimal lag in the response of the monetary authorities to changes in the goal variables. Reaction functions were first estimated for the U.K. and West Germany with OLS combined with the Cochrane-Orcutt serial correlation correction. These equations were then reestimated using the instrumental variable technique combined with the Cochrane-Orcutt serial correlation correction procedure. Reaction functions for the Bank of Canada were estimated with the OLS and IV procedures, since no problems with serial correlation were found.

Table 37 summarizes the findings of this study by identifying whether changes in the short-term interest rate, the unemployment rate, the output gap, the international reserves, the effective exchange rate, the trade balance, the balance of payments (in the current account), the wage rate, the inflation rate and the budget surplus have affected monetary policy in each of the countries. Rows

(1), (2), (3) and (4) summarize the influence of external balance measures on monetary policy. The money supply policies in the United Kingdom and West Germany have been permanently affected by some external trade balance measure--the effective exchange rate and/or the international reserves. In addition to the international reserves variable, the German authority responded temporarily to the trade balance variable by following restrictive monetary policies. These results suggest that the Bundesbank was trying to maintain external stability by making permanent and temporary adjustments in monetary policy. The monetary base responded positively to an increase in the index of the effective exchange rate.

A procyclical response to the unemployment variable (West Germany) and the output gap variable (Canada) is indicated. The output gap variable has a positive sign and is significant for Canada at the 5 % level of confidence. The positive sign on the output gap variable indicates a procyclical response. That is, the monetary base was expanded in response to an increase in demand for money that accompanies an upswing in the level of economic activity. Changes in the unemployment rate variable exerted no lasting effect on the $M\dot{B}$ in West Germany (since the sum of coefficients on this variable is insignificant), but some temporary procyclical adjustments in the monetary base took place (as is evident from one significant negative lagged coefficient).

Concerning a monetary response to fiscal actions, the results are mixed. The sum of coefficients on the budget surplus variable is insignificant for the U.K. ruling out a permanent or lasting relationship between the budget surplus and the money supply. However, a study of the individual lagged coefficients on the budget surplus variable reveals the presence of one individual significant negative coefficient. A negative budget surplus-money supply linkage suggests that the central bank in the U.K. accommodates, at least temporarily, an increase in the public sector borrowing requirements. The fiscal policy variable exerted no significant influence on monetary policy in West Germany. An explanation for this is found in the institutional framework of the Bundesbank. The central bank of West Germany has exhibited substantial independence in the post world war period. The government is responsible for fiscal policy while the Bundesbank is solely responsible for designing and executing monetary policy. The monetary authority in Canada has responded in an oscillatory fashion to changes in the fiscal policy variable. The response of the monetary authority to a unit change in the budget surplus (as a ratio of trend real GNP) is distributed over four quarters. While for the first two quarters no significant response is detected, in the third quarter the central bank reduces the growth rate of the monetary base. However, in the next period a significant increase in $\dot{MB}$ is noted, and this effect is so significant that the sum of coefficients on the budget surplus variable is significant at the 10% level. The Canadian central bank seems to respond more to the macro consequences of the change in surplus than to the money consequences of the increase in the surplus.

The sum of coefficients on the short-run interest rate variable is found to be negatively related to policy actions in Canada. It is difficult to explain this result as it seems to indicate that the Canadian central bank used monetary policy to reinforce rather than to stabilize the financial market fluctuations. Financial market variables (i.e., changes in the short-term interest rate) had some temporary effect on the monetary policy in the U.K., as is evident from a significant positive individual coefficient on the short-term interest rate variable, even though variations in the short-term interest rate did not exercise a lasting impact on the monetary policy.

One surprising result of the study is the insignificant coefficient on the inflation rate variable for the United Kingdom and West Germany. It might be expected that inflation would be one of the most important determinants of monetary policy because of the relatively strong public concern expressed over an accelerating price level. No support for the wage push hypothesis has been established.

Table 37 also shows how the lag length over which monetary authorities adjust to changes in economic variables differs among countries. Rather than imposing arbitrary restrictions on the model in terms of predetermined lag length, the information contained in the data set has been used to determine the actual lags in policy actions. This variable lag pattern allows greater degrees of freedom than is experienced with the imposition of equal lag length on all the independent variables.

The estimated reaction functions indicate that the monetary policies in the United Kingdom and West Germany have been permanently affected by some external trade balance measure--the effective exchange rate in the former case and international reserves in the latter. Other economic variables under consideration have no lasting impact on the formulation of monetary policy in the U.K. and West

Germany. The monetary base in Canada is affected by changes in the output gap, interest rate changes and budget deficits.

Table 37. A Summary Matrix of the Signs and Significance of Sums of Coefficients: 1960:2 - 1983:4.

	Independent Variable	United Kingdom	West Germany	Canada
(1)	$I\dot{R}$	0(1)	+(0)**	na
(2)	ΔEEXR	+(2)**	0(1)	na
(3)	ΔTB	na	0(3)[b]	na
(4)	ΔBOPCB	na	na	na
(5)	ΔUN	0(0)	0(3)[b]	na
(6)	OG	na	na	+(0)*
(7)	$\dot{W}$	na	na	na
(8)	Δr	0(4)[a]	na	-(4)**
(9)	$\dot{P}$	na	na	0(2)
(10)	SUR	0(6)[b]	na	+(3)[c]**

Notes:

In this table the sign and the significance of the sum of the coefficients on different explanatory variables is reported.

+, -, and 0 denote a positive significant, a negative significant, and an insignificant sum of coefficients respectively.

An * denotes significance at the 5 percent level; the double asterisk ** denotes significance at the 10 percent level.

For some explanatory variables the sum of the coefficient is not statistically significant, but one or more individual lagged coefficients are significant. The superscripts (a), (b), and (c) denote the significance (at the 10 percent level) of one or more positive individual coefficients, negative individual coefficients, and one or more coefficients of both signs respectively.

Figures in parentheses refer to the appropriate lag length (in quarters).

na: not applicable; these variables are not included as explanatory variables in the restricted model.

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APPENDIX

DEFINITION OF VARIABLES, BY COUNTRY

All variables are seasonally unadjusted unless mentioned otherwise.

The unit of observation for all variables is a quarter. Data has been drawn from International Financial Statistics (IMF), Main Economic Indicators (OECD), and Main Economic Indicators: Historical Statistics (OECD).

I. United Kingdom

MB = Reserve Money, millions of pounds sterling.
Source: IFS.

TBR_{PA} = Treasury bill rate, 91 days, per cent per annum period average; IFS.

TBR_{PE} = Treasury bill rate, per cent per annum, 91 days, period end; OECD.

W = Hourly earnings in manufacturing; 1975=100; OECD.

U = Unemployment as percent of civilian labor force; OECD.

CPI = Consumer price index, all items, 1975=100; OECD.

WPI = Wholesale price index (manufacturing output): total excluding food, beverages and tobacco, 1975=100; OECD.

EXR = U.S. dollar per pound sterling, market rate/par or central rate, end of period; IFS.

EEXR = Index of effective exchange rate. It is a measure of changes in the effective exchange rate. It is an index combining the currency in question and twenty other major currencies with weights derived from the Fund's Multilateral Exchange Rate Model (MERM); IFS.

IR = Official reserves: total, million, SDR's end of period; OECD.

TB = Trade Balance (fob-cif), millions of pound sterling per quarter, seasonally adjusted; OECD.

BOP = Balance of payments; net trade, millions of pound sterling per quarter; OECD.

IPD = Implicit price deflator, 1975=100, seasonally adjusted; OECD.

GDP = Gross domestic product at factor cost, millions of pound sterling, annual rates, seasonally adjusted; OECD.

SUR = Actual budget deficit (-) or surplus (+), billions of pound sterling per quarter; IMF. (Data on this variable is on a cash-flow basis).

II. West Germany

MB = Reserve money, millions of Deutsche mark, IFS.

r = Call money rates, per cent per annum, end of period; OECD.

W = Hourly earnings in manufacturing, 1975=100; OECD.

U = Unemployment (registerd unemployed) as percent of civilian labor force; OECD.

CPI = Consumer price index, all items, 1975=100; OECD.

EXR = Exchange rate, Deutsche mark per U.S. dollar, par or central rate, end of period. EEXR = Index of effective exchange rate; IFS.

IR = Official reserves: total, million SDR's end of period; OECD. (Official reserves comprise of gross holdings of special drawings rights and foreign exchange plus gold holdings plus reserve position in the IMF).

BOP = Balance of payments, current balance, million Deutsche marks; OECD.

TB = Trade balance (fob-cif) billion DM, monthly averages, OECD.

IPD = Implicit price deflator, 1975=100; OECD.

DEBT = Government debt, billions of Deutsche marks; IFS.

DEF = Deficit (-) or Surplus (+), billions of Deutsche marks; IFS

III. Canada

MB = Reserve money, billions of Canadian $; IFS.

TBR = Treasury bill rate, 91 days, per cent per annum, end of period; OECD.

W = Hourly earnings in manufacturing (seasonally adjusted); OECD.

U = Unemployment as percent of civilian labor force (seasonally adjusted); OECD.

CPI = Consumer price index, all items, 1975=100; OECD.

EXR = Exchange rate, end of period, Canadian $ per U.S. $; IFS.

EEXR = Effective exchange rate; IFS.

IR = Official reserves: total, million SDR's end of period; IFS. (Total official reserves include gross holdings of special drawing rights and foreign exchange plus gold holdings plus reserve position in IMF).

BOP = Balance of payments, net trade, billions of Canadian $; OECD.

BOP_{CB} = Balance of payments, current balance, billions of Canadian $; OECD.

GNP = Gross National Product at factor cost, billions of Canadian $ annual rates, seasonally adjusted; OECD.

IDP = Gross domestic product implicit price deflator, 1975=100, seasonally adjusted; OECD.

RGNP = Real GNP at 1975 market price, seasonally adjusted; IFS.

DEBT = Total outstanding debt of government, billions of Canadian $, IFS.

SUR = Actual surplus (+) or deficits (-); billions of Canadian $; Statistics Canada, National Income and Expenditure Accounts, Several Volumes.

VITA

Deep Shikha was born on December 13, 1954, in Delhi, India, the daughter of Purshottam Chand Bansal and Shakuntala Devi. She completed secondary education at Arya Girls Higher Secondary School, Teliwara, Delhi in 1971. She graduated in 1974 and 1976 from University of Delhi with Bachelor of Arts and Master of Arts degrees in Economics respectively. In 1978, she met and married Dr. Vinod K. Gupta. She was awarded the Master's of Philosophy degree in Economics from the University of Delhi in 1981. Her thesis was on "Study of the Various Aspects of Time Deposits". From August 1976 to July 1981, she worked as an Assistant Professor in Economics at University of Delhi, India and then entered graduate program in Economics with a minor in Quantitative Business Analysis at Louisiana State University in August 1981. During her graduate career she was employed by the University as a Research Assistant (August 1981 to December 1983), Teaching Assistant (January 1984 to August 1985) and Instructor (since August 1985). She is currently a candidate for the degree of Doctor of Philosophy.

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Title of Dissertation: Determinants of the Money Supply in the United Kingdom, West Germany, and Canada

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